Initial Application for an Alternate Liner Demonstration

Belle River Power Plant
Bottom Ash Basins Coal Combustion Residuals Unit

November 2020

Prepared For:

DTE Electric Company
4505 King Road
China Township, Michigan 48054

Prepared By:

TRC
1540 Eisenhower Place
Ann Arbor, Michigan 48108

Kelly C. Cratsenburg, CPG
Sr. Project Hydrogeologist

Vincent E. Buening, CPG
Sr. Project Manager/Hydrogeologist

Graham Crockford, CPG
CCR Program Manager/Unit Leader ECC-E

TABLE OF CONTENTS

FIGURES

APPENDICES

Executive Summary

TRC, on behalf of DTE Electric Company (DTE Electric), has prepared this Initial Application for an Alternate Liner Demonstration pursuant to the XX, XX, 2020 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments (40 CFR § 257.71(d)) (Part B Rule) for the Belle River Plant Bottom Ash Basins (BRPP BABs) Coal Combustion Residuals (CCR) Unit.

This application and its attachments demonstrate how DTE Electric qualifies for and should be granted the opportunity to complete and submit an Alternate Liner Demonstration per 40 CFR § 257.71(d)(1)(i) for approval as continued operation of the BRPP BABs CCR Unit would pose no reasonable probability of adverse effects to human health or the environment in the future based on the following:

- Compliance with all provisions of the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule); April 15, 2015, 40 CFR part 257 subpart D, including a sufficient groundwater monitoring network under § 257.91;
- The groundwater monitoring program meets the requirements of § 257.93 and § 257.94, and per analytical data collected as part of the program, remains in detection monitoring;
- The presence of a natural geologic barrier (more than 80 feet of native clay-rich soil) that provides the equivalent, or better level of protection from potential migration of contaminants than a composite liner defined in 40 CFR § 257.70(b);
- Sufficient documentation that the unit meets all the location restrictions under § 257.60 through § 257.64, and;
- The BRPP BABs CCR Unit is not located adjacent to a surface water body.

1.0 Regulatory Framework and Site Background

Regulatory Framework - On April 17, 2015, the U.S. EPA issued the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule), 40 CFR 257, Subpart D, to regulate the disposal of CCR materials generated at coal-fired units. The rule is being administered under Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. § 6901 et seq.). On XXXX XX, 2020, the EPA Administrator issued revisions to the CCR Rule that required all unlined surface impoundments to initiate closure by April 11, 2021, unless an alternative deadline is requested and approved (40 CFR 257.103) or an initial application for an Alternate Liner Demonstration is prepared per 40 CFR § 257.71(d) and submitted by November 30, 2020. The April 11, 2021 deadline to cease receipt of waste and initiate closure will be tolled upon submission of a complete application, and until such time that EPA makes a final decision on the application or subsequent demonstration. The initial application for an Alternate Liner Demonstration per § 257.71(d)(1)(i) must include the location of the facility and identify the specific CCR surface impoundment(s) for which the demonstration will be made. The application must also include all the following information:

- **§ 257.71(d)(1)(i)(A)** – A certification signed by the owner or operator that the CCR Unit is in full compliance with this subpart except for § 257.71(a)(1);
- **§ 257.71(d)(1)(i)(B)** – Documentation supporting the certification required under § 257.71(d)(1)(i)(A) which includes the following:
  1. Documentation that the groundwater monitoring network meets the requirements of § 257.91. This must include documentation that the existing network of groundwater monitoring wells is sufficient to ensure detection of any groundwater contamination resulting from the impoundment, based on direction of flow, well location, screening depth and other relevant factors;
  2. Documentation that the CCR surface impoundment remains in detection monitoring pursuant to § 257.94 as a precondition for submitting an application. This includes documentation that the groundwater monitoring program meets the requirements of § 257.93 and § 257.94;
  3. Documentation that the unit meets all the location restrictions under § 257.60 through 257.64;
  4. Documentation of the most recent structural stability assessment required by § 257.73(d); and
  5. Documentation of the most recent safety factor assessment required by § 257.73(e).
- **§ 257.71(d)(1)(i)(C)** – Documentation of the design specifications for any engineered liner components, as well as all data and analyses the owner or operator of the CCR surface impoundment relied on when determining the materials are suitable for use and that the construction of the liner is of good quality and in-line with proven and accepted engineering practices;
- **§ 257.71(d)(1)(i)(D)** – Facilities with CCR surface impoundments located on properties adjacent to a water body must demonstrate that there is no reasonable probability that a complete and direct transport pathway (*i.e.*, not mediated by groundwater) can exist between the impoundment and any nearby water body; and

- **§ 257.71(d)(1)(i)(E)** – Upon submission of the application, and any supplemental materials submitted in support of the application to the Administrator or the Participating State Director, the owner or operator must place the complete application in the facility's operating record as required by § 257.105(f)(14).

The documentation that must be provided to the EPA per § 257.71(d)(1)(i) to demonstrate that the above criteria has been met for an initial Alternate Liner Demonstration is provided within this report.

Site Background - The BRPP is located in Section 13, Township 4 North, Range 16 East at 4505 King Road, China Township in St. Clair County, Michigan (**Figure 1**). The BRPP, including the BABs, were constructed in the early 1980s.

The property has been used continuously as a coal fired power plant since the Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984. The BABs are designed to manage sluiced bottom ash and have been in operation since the BRPP began operation. The BABs are routinely cleaned out and CCR is either beneficially reused or disposed at the Range Road Landfill (RRLF).

The BRPP BABs are two adjacent physical sedimentation basins that are slightly raised CCR surface impoundments referred to as the North and South BABs, located north of the BRPP near the Webster Drain **(Figure 2)**. The BABs receive sluiced bottom ash and other process flow water from the power plant. Discharge water from each BAB flows over an outlet weir that gravity flows to a site storm water conveyance network of ditches and pipes, then flows into the diversion basin (DB) CCR Unit. The North and South BABs are located north of the BRPP main building and run roughly east to west approximately 420 feet long by 120 feet wide with bottom elevations of approximately 580 feet relative to the North American Vertical Datum (NAVD) 1988, with outflow weir elevations of approximately 590.25 feet relative to the NAVD 1988. The capacity of the North BAB is approximately 2.4 million gallons and the capacity of the South BAB is approximately 2.5 million gallons. The BABs are approximately 0.88 and 0.87 acres, respectively.

2.0 Natural Clay Liner

Pursuant to Part B, in order to meet the requirements of 40 CFR § 257.71(d)(1), the owner or operator must demonstrate that, without a composite liner, the continued operation of the unit would pose no reasonable probability of adverse effects to human health or the environment. This is demonstrated when the surface impoundment has not and will not result in groundwater concentrations above the relevant GWPS at the unit boundary (health based or background, whichever is higher).

The risks posed by the continued operation of the BABs CCR Unit are mitigated by the geologic and hydrogeologic conditions at the site, and through DTE Electric's demonstrated compliance with the CCR rules. The following paragraphs document the existing site conditions, identification of potential receptors, and how potential risks have been mitigated.

Site Geology - The geology of St. Clair County consists of approximately 101 to 400 feet of glacial deposits, primarily lacustrine deposits, till, and, to a lesser extent, sand and gravel outwash, overlying a variety of bedrock surfaces[1]. The thicker glacial deposits, predominantly low permeability clay-rich deposits, are present toward the central portion of the county, including in the area of the BRPP BABs CCR Unit. These thick low permeability subsurface conditions are present on a regional basis due to continental glaciation. The *Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six Southeast Michigan Coal Combustion Residual Units,* previously submitted to the EPA in December of 2018 also contains additional information on the natural clay liner evaluation. This report can be found here: Clay Liner Equivalency Report. Bedrock in the county includes the Michigan Formation, Marshall Sandstone, Coldwater Shale, Sunbury Shale, Berea Sandstone, Bedford Shale, and Antrim Shale.

In the vicinity of the site, the Devonian Bedford and/or Antrim Shale bedrock dips to the northwest and is generally covered by more than 100 feet of unconsolidated clay, silt, sand, and gravel. In this area, generally on the eastern side of the county, the glacial deposits are predominantly silty-clay till and lacustrine deposits with lenses of sand and gravel. Where present, unconsolidated sand and gravel deposits within the till and lacustrine deposits are generally used for water supply throughout the county. Approximately 85 percent of the water supply wells in St. Clair County are completed in the glacial deposits compared to approximately 13 percent installed in bedrock[1].

The current topography of the St. Clair area gently undulates consisting of floodplain, stream terrace, and lakeshore deposits. The St. Clair River is the major surface water body in the county and runs along the eastern boundary of the county. Regional groundwater and surface water flow would be expected to be to the east towards the St. Clair River.

The site subsurface geology is based on information from historical borings advanced during initial design of the BRPP, in addition to the soil boring data collected from around the BABs

[1] Beth A. Apple and Howard W. Reeves, 2007, Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p.

during the groundwater monitoring system installation. This information documents that the BRPP BABs CCR Unit is underlain by more than 130 feet of vertically thick and laterally continuous silty-clay rich deposits, with some discontinuous sand-rich deposits encountered no shallower than 86 feet-below ground surface (feet-bgs) with the lower confining Bedford Shale generally encountered from 135 to 145 feet-bgs. However, along the southeastern portion of the BRPP BABs CCR Unit, clay-rich deposits extend to the top of the Bedford shale and no aquifer is present beneath this portion of the CCR Unit (refer to the Groundwater Monitoring Systems Summary Report (GWMS, October 2017) located on the DTE Compliance Data and Information website (BRPP GWMS) and **Figures 3 through 6**.

Site Hydrogeology – A definitive groundwater flow direction is not evident around the BABs in 15 rounds of groundwater monitoring which is likely due to:

- The fact that the screened intervals of these monitoring wells and the top of the uppermost aquifer elevation encountered within each of the BABs CCR Unit monitoring wells varies up to 46 feet vertically; and
- The degree of interconnection is limited (specifically around MW-16-02).

Therefore, given the horizontally expansive clay with substantial vertical thickness, the heterogeneity of the glacial deposits (with the top of the uppermost aquifer elevation across the BABs, where present varying up to 46 feet vertically), the no flow boundary where no sand or gravel is present in the southeastern portion of the BABs CCR Unit area, and the lack of hydraulic interconnectedness of the uppermost aquifer encountered at the BABs in some areas, it is not appropriate to infer horizontal flow direction or gradients across the BABs CCR Unit. The GWMS report (BRPP GWMS) contains additional details related to the site hydrogeology.

Hydraulic conductivities measured within the CCR monitoring wells set within the upper portion of the uppermost aquifer across BRPP were evaluated using single well hydraulic conductivity tests (e.g., slug tests) performed in 2016. The calculated hydraulic conductivity of the uppermost aquifer is approximately 0.5 feet/day in the BABs CCR Unit area. This low hydraulic conductivity further demonstrates the low groundwater yield potential across the conservatively interpreted, potential uppermost aquifer encountered at the site. A definitive horizontal flow direction in the BABs CCR Unit area is not present; therefore, it is not appropriate to estimate the horizontal time of travel. Because there is no clear flow direction, inter-well statistical tests are inappropriate for detection monitoring of this basin.

For further discussion on the site groundwater flow, see **Appendix A** for the 2019 Annual Groundwater Monitoring Report (GWMR). The 2018 and 2017 GWMR reports can be located on the DTE CCR Compliance Data and Information website (BRPP 2018 GWMR and BRPP 2017 GWMR). Refer to **Figures 7 and 8** for the most recent potentiometric surface maps.

Vertical Flow Potential to Uppermost Aquifer – As stated previously, the BRPP is a natural silty-clay site, and the presence of the natural clay liner has been verified by numerous historical soil borings and confirmed by the twelve soil borings installed as part of the CCR monitoring well installation program at the BABs and DB CCR Units. Therefore, the geology and hydrogeology of the site provides a very high level of environmental protection of the uppermost aquifer. Based on the site geology and hydrogeology, there is no reasonable probability for the impoundments to have adverse effects to the off-site uppermost aquifer groundwater, human health or the environment given the relatively short duration of continued operation. Groundwater occurring in the deep confined uppermost aquifer is protected from CCR constituents in the BABs by a clay-rich aquitard with low hydraulic conductivity that is 82 or more feet thick from the bottom of the BABs. Using the hydrogeologic information for the site, the time of travel for water from the base-grade elevation of the BABs down to the uppermost aquifer can be calculated using the following formula:

$$V = Ki/Ne$$

Where:

V = Velocity (feet/day)

K = Hydraulic Conductivity (3 x 10^{-8} cm/s based on high end silty clay-rich data)

i = Downward Vertical Gradient (conservatively assumed to be one foot/foot)

Ne = Effective Porosity (0.5 for clay-rich soil)

From the above formula, the maximum downward flow velocity through the silty-clay confining unit to the uppermost aquifer is 6 x 10^{-8} cm/sec, or 0.063 feet/year. Therefore, the time of travel for liquid from the base of the BABs through 82 feet of silty-clay (thinnest potential section of silty-clay confining unit above the uppermost aquifer at the base of the BABs CCR Unit) to the uppermost aquifer is approximately 1,300 years. Therefore, given that BRPP operations began in 1984, and the fact that DTE Electric has publicly announced that it plans to cease operations at the BRPP by 2030 (refer to the 2019 Integrated Resource Plan (IRP) presented to and approved by the Michigan Public Service Commission (IRP)), there is no potential for the uppermost aquifer CCR groundwater monitoring system wells to be affected by the BRPP CCR BABs Unit. Therefore, the natural clay-rich soil liner underlying the BABs CCR Unit consists of thick, low hydraulic conductivity clay, that provides the same, or better level of protection from potential migration of contaminants than the composite liner defined in 40 CFR § 257.70(b).

Groundwater Use - Water supply wells are present within the sand and/or gravel rich aquifer units within the lacustrine unconsolidated sediments at depths of around 100 feet-bgs within between one-half and one mile to the west and southwest of the BRPP. There is no on-site use of groundwater at the BRPP. Surface water bodies present in the area of the BRPP include the Belle River (as close as 2,000 feet southwest and south of BRPP) and the St. Clair River (as close as one mile to the east of BRPP).

Detection Monitoring - A groundwater monitoring system has been established for the BRPP BABs CCR Unit (BRPP GWMS). The detection monitoring well network for the BABs CCR Unit currently consists of five monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2. Detection monitoring at the monitoring well system has been completed since 2017 in accordance with § 257.93 and § 257.94 with compliance as required in § 257.71(d)(1)(i)(B)(2) being documented in the 2017, 2018 and 2019

Annual Reports prepared in accordance with § 257.90. See Appendix A for the 2019 GWMR, and the DTE website for the 2018 and 2017 GWMRs (BRPP 2018 GWMR and BRPP 2017 GWMR).

3.0 Facility Compliance

DTE Electric has a public repository of documents in accordance with 40 CFR § 257.107 which can be found here: DTE CCR Compliance Data and Information. This repository demonstrates that the BRPP facility is in compliance with all record keeping, notification and internet posting requirements as required by 40 CFR 257 Subpart D. DTE Electric audited their records to identify any gaps in compliance and none were noted. As required by § 257.71(d)(1)(i)(A), a certification signed by the owner or operator that the BRPP BABs CCR Unit is in full compliance with this subpart, except for § 257.71(a)(1), has been included as **Appendix B**. A summary of the key compliance metrics for the BRPP BABs is discussed below.

Groundwater Monitoring System § 257.71(d)(1)(i)(B)(1) – In accordance with 40 CFR § 257.91, a P.E. certified groundwater monitoring system is established for the BRPP BABs CCR Unit (BRPP GWMS). The monitoring well network for the BABs CCR Unit currently consists of five monitoring wells that are screened in the uppermost aquifer and are sufficient to ensure detection of groundwater contamination resulting from the BABs CCR Unit. Given the presence of the thick natural clay-rich liner hydraulic barrier as discussed in Section 2 and the relatively small foot print of the BABs, the perimeter groundwater monitoring well network is appropriate to monitor the BRPP BABs CCR Unit. The monitoring well locations are shown on **Figure 2**. It should be noted that the uppermost aquifer is not present in the southeastern portion of the BABs CCR Unit. Well Construction and Soil Boring Logs for the monitoring network are attached as **Appendix C**.

Groundwater elevation data collected during the 2019 sampling events show that groundwater flow conditions within the uppermost aquifer are consistent with previous monitoring events. Groundwater potentiometric elevation summary maps are shown on **Figure 7 and Figure 8**, respectively. Additional figures for 2017 and 2018 can be found on the DTE website located here: BRPP 2018 GWMR and BRPP 2017 GWMR. There is a horizontally extensive clay with substantial vertical thickness of greater than 80 feet that isolates the uppermost aquifer from the BRPP BABs CCR Unit (refer to **Figures 3through 6** for geologic cross sections).

Detection Monitoring and Groundwater Statistical Analysis § 257.71(d)(1)(i)(B)(2) – The groundwater conditions have been consistent through all monitoring events completed since 2017. This continues to demonstrate that the downgradient wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the BRPP BABs CCR Unit. This additionally demonstrates the unit has been in compliance with detection monitoring performed in accordance with § 257.94 as required in § 257.71(d)(1)(i)(B)(2). This is documented in the 2017 through 2019 Annual Reports prepared as required by 40 CFR § 257.90. The 2019 GWMR is attached as **Appendix A,** 2018 and 2017 GWMRs can be found on the DTE website located here: BRPP 2018 GWMR and BRPP 2017 GWMR.

Since establishment of the groundwater monitoring system, DTE Electric performs groundwater sampling semi-annually in accordance with the Groundwater Statistical Evaluation Plan (SEP, October 2017) located on the DTE website here: BRPP SEP.

Statistical evaluation of groundwater data is completed each time samples are collected in accordance with 40 CFR § 257.93. Statistical methods for the BABs CCR Unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the relatively small footprint of the BABs, and the low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR Unit (such as the consistency in concentrations of water quality data). Refer to the SEP (October 2017) located on the DTE website here: BRPP SEP, for further details on the statistical analysis and the 2019 GWMR attached as **Appendix A** for a summary of groundwater monitoring data and statistical analysis completed at each monitoring location. The 2018 and 2017 GWMRs are located on the DTE website here: BRPP 2018 GWMR and BRPP 2017 GWMR.

Location Standards § 257.71(d)(1)(i)(B)(3) – The BRPP BABs CCR Unit is compliant with the location restrictions of 40 CFR § 257.60-64. The location restriction certification report (LR, October 2018) is available on the DTE website here: BRPP LR.

Structural Stability and Safety Factor Assessments § 257.71(d)(1)(i)(B)(4 and 5) - Structural stability assessment and safety factor assessments, as required per 40 CFR §257.103 (f)(2)(v)(C)(7) and (8), are not required for the BRPP BABs surface impoundments and have therefore not been included with this submittal.

Documentation of Design Specifications § 257.71(d)(1)(i)(C) – As the BRPP BABs rely on the natural clay liner, a design for the liner was not performed. However, prior to the construction of BRPP, a significant geotechnical investigation demonstrated extensive clay deposits across the entire BRPP site as documented in a 1976 *Subsurface Investigation and Foundation Report* by Bechtel. The Bechtel report included an evaluation of the native clay soils that were used in construction of the BRPP BABs CCR Unit surface impoundments, which are incised into the natural clay liner. The evaluation included soil hydraulic conductivity testing showing the native clay soil has a hydraulic conductivity of around 2×10^{-8} cm/s. The 1976 Bechtel report is provided in **Appendix D**.

Facilities with CCR surface impoundments located on properties adjacent to a water body § 257.71(d)(1)(i)(D) – The BRPP BABs CCR Unit is not located adjacent to a surface water body.

Alternate Liner Application Placed in the Operating Record - § 257.71(d)(1)(i)(E) - This alternate liner demonstration application and supplemental materials submitted in this application have been placed in the facility's operating record as required by § 257.105(f)(14).

4.0 Conclusions

This document demonstrates how the BRPP BAB CCR Unit meets the provisions of the initial application for an alternate liner demonstration by:

- Demonstrating continued compliance with the CCR Rule for all record keeping, notification and internet posting requirements. In addition, detection monitoring is completed at the established groundwater monitoring network as required by 40 CFR § 257.93 and § 257.94 and annual reporting as required by 40 CFR § 257.90 documents compliance with the detection monitoring program;
- Demonstrating the presence of a natural geologic barrier underlying the BRPP BABs CCR Unit, that consists of a thick (> 80 feet), low hydraulic conductivity clay, that provides the same, or better level of protection from potential migration of contaminants than the composite liner defined in 40 CFR § 257.70(b);
- Demonstrating that the BRPP BABs CCR Unit is compliant with the location restrictions of 40 CFR § 257.60-64 and that the structural stability and safety factor assessments as required per 40 CFR § 257.103 (f)(2)(v)(C)(7) and (8) are not required;
- Including the BRPP BABs impoundment natural clay liner soil assessment performed prior to construction of the BABs surface impoundments;
- Documenting the BRPP BABs are not located adjacent to a surface water body; and
- Placing this alternate liner demonstration application and supplemental materials submitted in this application in the facility's operating record as required by § 257.105(f)(14).

Therefore, it is requested that the EPA approve DTE Electric's initial application to complete an alternate liner demonstration prepared per 40 CFR § 257.71(d)(i) for the BRPP BABs CCR Unit.

5.0 References

DTE Electric Company website: DTE CCR Compliance Data and Information

TRC Environmental Corporation. January 2020. 2019 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP 2019 GWMR).

TRC Environmental Corporation. January 2019. 2018 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP 2018 GWMR).

TRC Environmental Corporation. January 2018. 2017 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP 2017 GWMR).

TRC Environmental Corporation. October 2017. Groundwater Monitoring Systems Summary Report - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP GWMS).

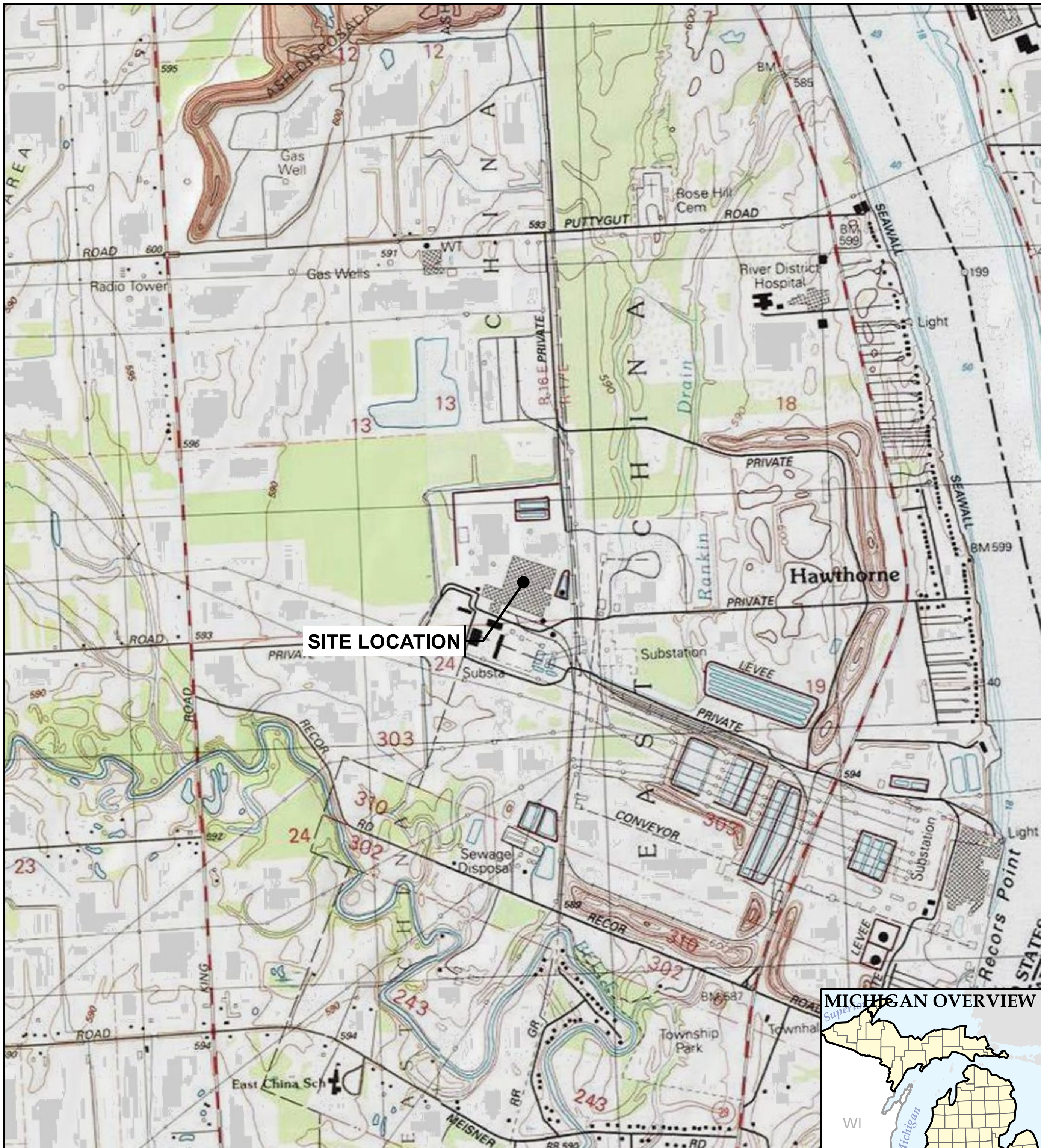
TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP SEP).

TRC Environmental Corporation. October 2018. Location Restrictions Demonstrations - DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan 48054 (BRPP LR).

TRC Environmental Corporation. December 2018. Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six Southeast Michigan Coal Combustion Residual Units (Clay Liner Equivalency Report).

Bechtel. August 1976. Subsurface Investigation and Foundation Report – The Detroit Edison Company, Belle River Units 1 & 2.

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
TRC - GIS

PROJECT:	DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	DRAWN BY:	S. MAJOR
		CHECKED BY:	
		APPROVED BY:	
		DATE:	DECEMBER 2019
TITLE:	SITE LOCATION MAP	PROJ. NO.:	320511.0003
		FILE:	320511-0003-001slmMB.mxd
		FIGURE 1	

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND, GRAVEL OR OTHER SATURATED ZONE WAS ENCOUNTERED ABOVE THE SHALE BEDROCK IN THIS LOCATION. THEREFORE, AN AQUIFER WAS NOT ENCOUNTERED AND A MONITORING WELL WAS NOT INSTALLED.

N

0 200 400 Feet
1 " = 200 '
1:2,400

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	K. CRATSENBURG		
APPROVED BY:	V. BUENING		**FIGURE 2**
DATE:	NOVEMBER 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 320511-0003-016.mxd

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/23/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND, GRAVEL OR OTHER SATURATED ZONE WAS ENCOUNTERED ABOVE THE SHALE BEDROCK IN THIS LOCATION. THEREFORE, AN AQUIFER WAS NOT ENCOUNTERED AND A MONITORING WELL WAS NOT INSTALLED.

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
CROSS SECTION LOCATOR MAP

DRAWN BY:	A. ADAIR	PROJ NO.:	370029.0003
CHECKED BY:	K. CRATSENBURG	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	NOVEMBER 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

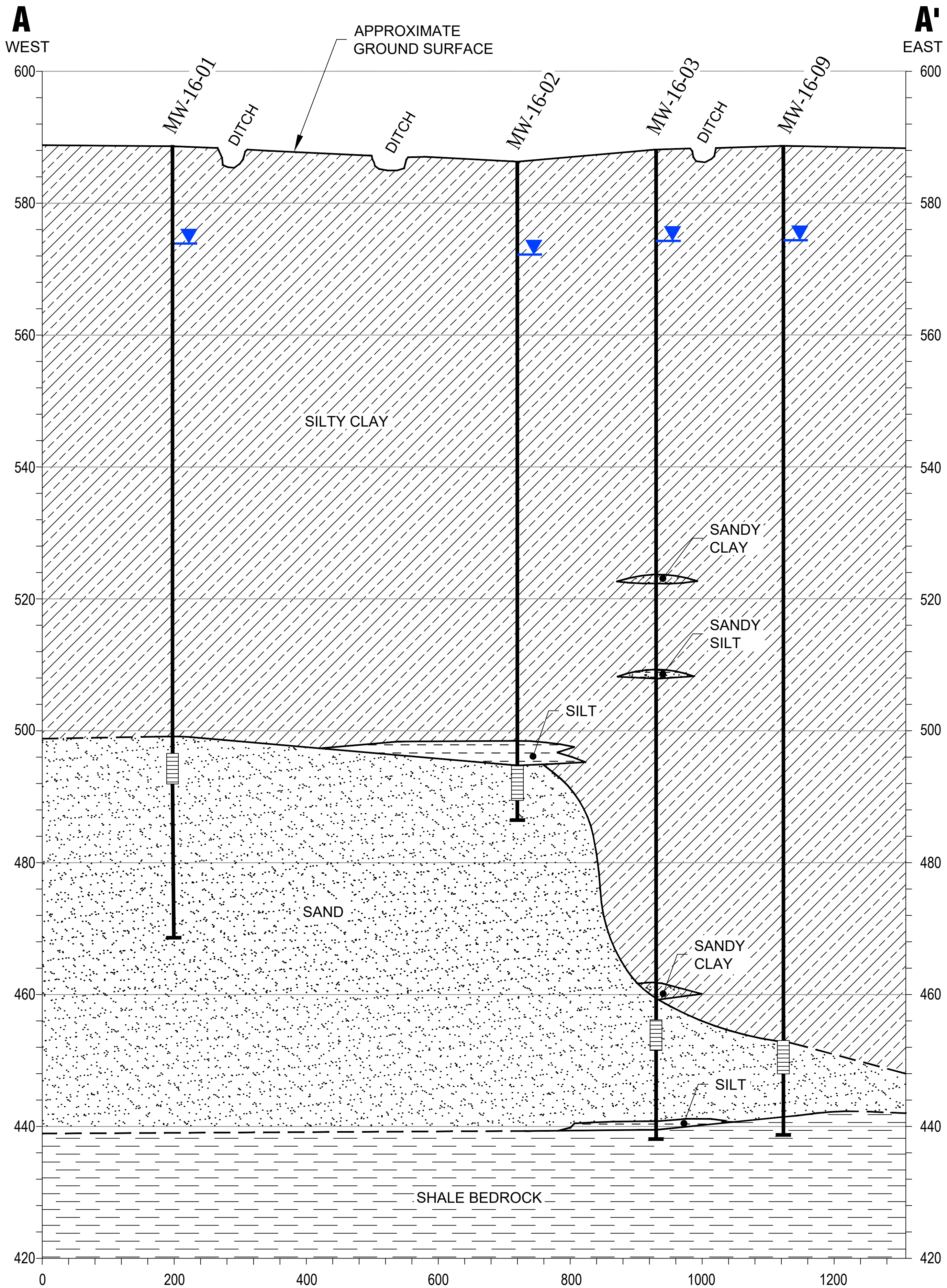
FILE NO.: 370029-0003-003.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 11/3/2020, 11:46:22 AM by AADAIR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\370029-0003-003.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'



LEGEND

- STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

Lithology Key

- SILTY CLAY
- SAND
- SILT
- SANDY CLAY
- SANDY SILT
- SHALE BEDROCK

SCALE IN FEET
VERTICAL 0 – 20
HORIZONTAL 0 – 200

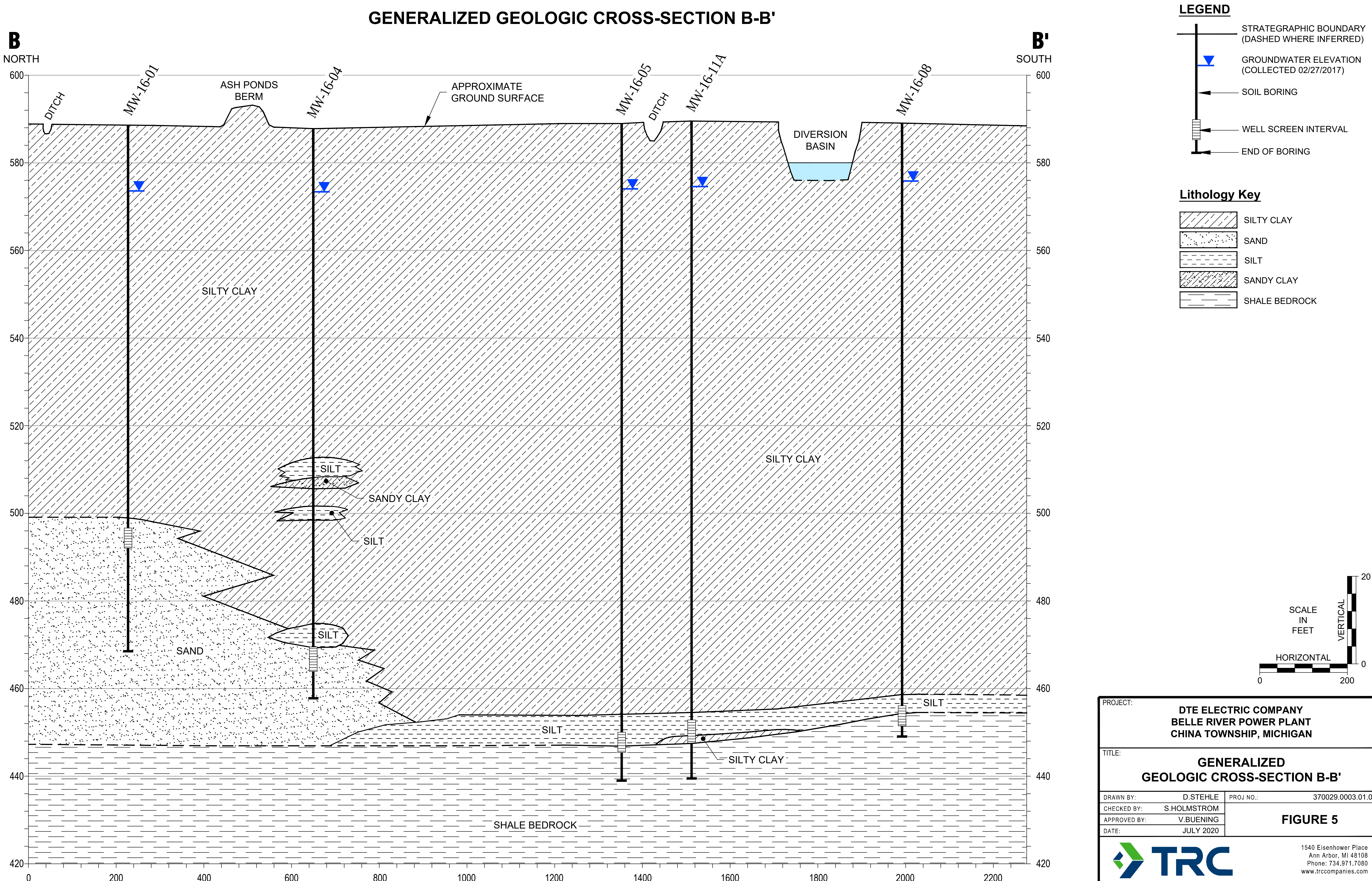
PROJECT:	DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT CHINA TOWNSHIP, MICHIGAN
TITLE:	GENERALIZED GEOLOGIC CROSS-SECTION A-A'
DRAWN BY: D.STEHLE	PROJ NO.: 370029.0003.01.01
CHECKED BY: S.HOLMSTROM	FIGURE 4
APPROVED BY: V.BUENING	
DATE: JULY 2020	

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 370029.0003.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES: DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_1; DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_2; XS aa wells; XS cc wells; XS DD wells;
DRAWING NAME: J:_TRC\DTE\Belle River PP\370029\0003\01\01_2020 HMP\ 370029.0003.01.01.04-05.dwg --- PLOT DATE: July 28, 2020 - 6:55AM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION B-B'

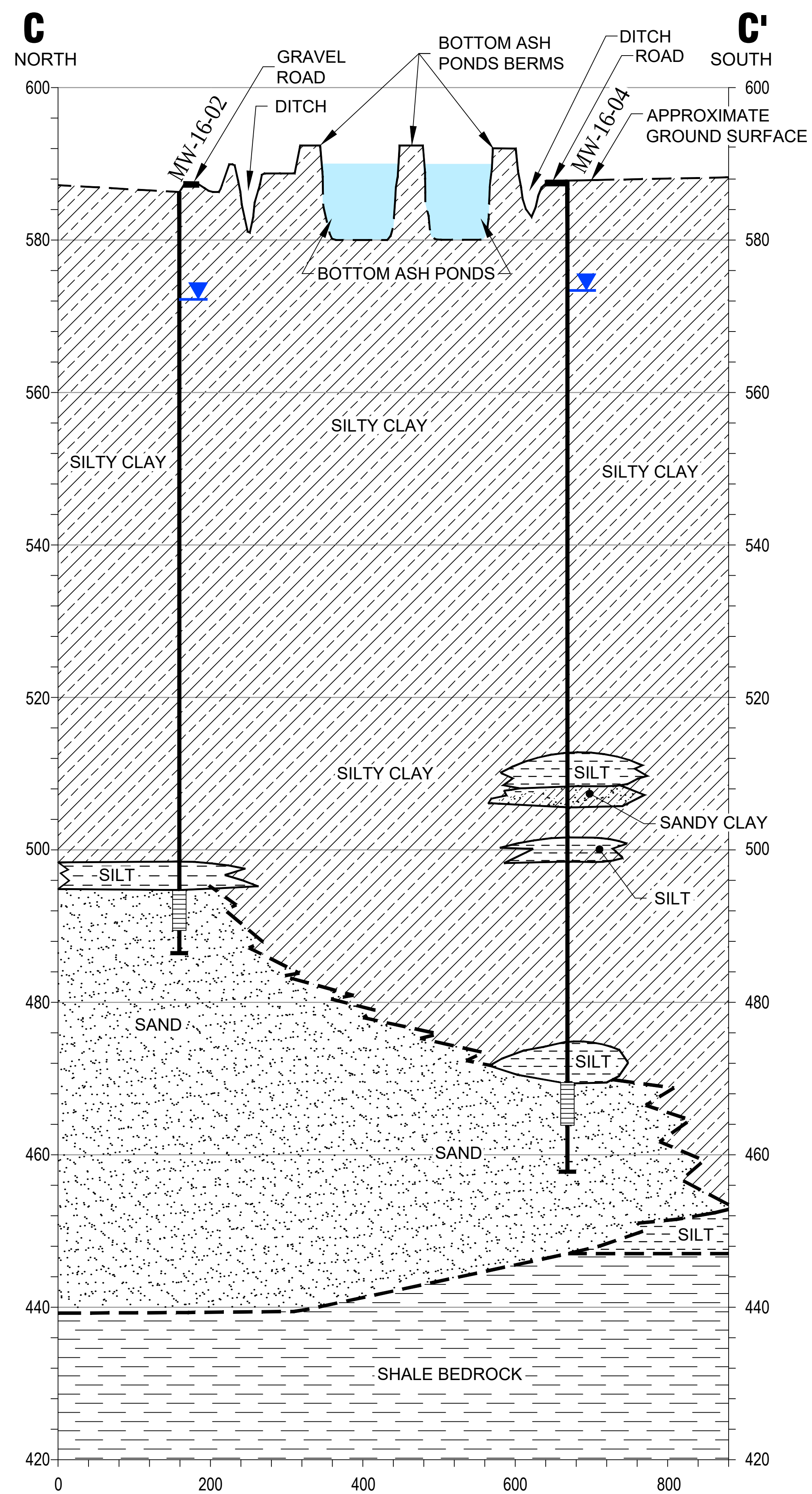
DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0003.01.01
CHECKED BY:	S.HOLMSTROM		FIGURE 5
APPROVED BY:	V.BUENING		
DATE:	JULY 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 370029.0003.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES: DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_1; DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_2; XS aa wells; XS cc wells; XS DD wells;
DRAWING NAME: J:_TRC\DTE\Belle River PP\370029\0003\0101_2020 HMP\370029.0003.01.01.04-05.dwg --- PLOT DATE: July 28, 2020 - 6:55AM --- LAYOUT: FIG05 XS BB

GENERALIZED GEOLOGIC CROSS-SECTION C-C'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

GROUNDWATER ELEVATION (COLLECTED 02/27/2017)

SOIL BORING

WELL SCREEN INTERVAL

END OF BORING

Lithology Key

SILTY CLAY

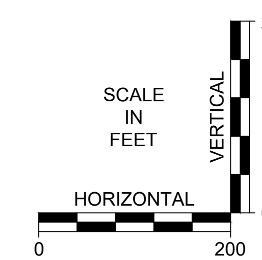
SAND

SILT

SANDY CLAY

SHALE BEDROCK

WATER



PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION C-C'

WORKING COPY

DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0003.01.01
CHECKED BY:	K.CRATSENBURG		**FIGURE 6**
APPROVED BY:			
DATE:	NOVEMBER 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 370029.0003.01.01.06.dwg

Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3

LEGEND

SOIL BORING

MONITORING WELL

DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/23/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND, GRAVEL OR OTHER SATURATED ZONE WAS ENCOUNTERED ABOVE THE SHALE BEDROCK IN THIS LOCATION. THEREFORE, AN AQUIFER WAS NOT ENCOUNTERED AND A MONITORING WELL WAS NOT INSTALLED.

N

0 200 400 Feet

1 " = 200 '
1:2,400

PROJECT: DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE: BOTTOM ASH BASINS
GROUNDWATER POTENTIOMETRIC
ELEVATION SUMMARY MARCH 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003
CHECKED BY:	K. CRATSENBURG		FIGURE 7
APPROVED BY:	V. BUENING		
DATE:	NOVEMBER 2020		

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 320511-0003-018b.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 11/3/2020, 14:42:36 PM by AADAIR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-018b.mxd

Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/23/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND, GRAVEL OR OTHER SATURATED ZONE WAS ENCOUNTERED ABOVE THE SHALE BEDROCK IN THIS LOCATION. THEREFORE, AN AQUIFER WAS NOT ENCOUNTERED AND A MONITORING WELL WAS NOT INSTALLED.

N

0 200 400
Feet
1 " = 200 '
1:2,400

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
BOTTOM ASH BASINS
GROUNDWATER POTENTIOMETRIC
ELEVATION SUMMARY SEPTEMBER 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003
CHECKED BY:	K. CRATSENBURG		
APPROVED BY:	V. BUENING	**FIGURE 8**	
DATE:	NOVEMBER 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 320511-0007-019.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 11/3/2020, 14:41:58 PM by AADAIR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0007-019.mxd

Appendix A
2019 Annual Groundwater Monitoring Report

2019 Annual Groundwater Monitoring Report

DTE Electric Company
Belle River Power Plant Bottom Ash Basins

4505 King Road
China Township, Michigan

January 2020

2019 Annual Groundwater Monitoring Report

DTE Electric Company
Belle River Power Plant Bottom Ash Basins

4505 King Road
China Township, Michigan

January 2020

Prepared For
DTE Electric Company

Graham Crockford, C.P.G.
Senior Project Geologist

David B. McKenzie, P.E.
Senior Project Engineer

TRC | DTE Electric Company
Final
X:\WPAAM\PJT2\320511\0003\GMR\BABS\R320511.3 BRPP BABS.DOCX

Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) Belle River Power Plant (BRPP) CCR Bottom Ash Basins (BABs) CCR unit. Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2019 activities at the BRPP BABs CCR unit.

The groundwater sampling results were below prediction limits for Appendix III indicator parameters during both the March and October 2018 semiannual monitoring events; therefore, no statistically significant increases (SSIs) were reported for the Belle River Power Plant Bottom Ash Basins (BRPP BABs) CCR unit. As such, DTE Electric continued detection monitoring at the BRPP BABs CCR Unit in 2019 pursuant to §257.94 of the CCR Rule.

The semiannual detection monitoring events for 2019 were completed in March and September 2019 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify SSIs in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed prediction limits. Detection monitoring data that have been collected and evaluated in 2019 are presented in this report.

Potential SSIs over prediction limits were noted for a few Appendix III constituents in one or more downgradient wells during the March and September 2019 monitoring events. These potential SSIs were either not statistically significant (i.e. verification resampling did not confirm the exceedance) or were evaluated and determined to be a result of natural variability in groundwater quality as documented in an alternative source demonstration (ASD) and not attributable to the BRPP BABs CCR unit. With the very thick continuous silty clay-rich confining unit beneath the BRPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from BRPP operations that began in the 1980s. Therefore, detection monitoring will be continued at the BRPP BABs CCR unit in accordance with §257.94 of the CCR Rule.

Section 1
Introduction

1.1 Program Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) Belle River Power Plant (BRPP) CCR Bottom Ash Basins (BABs). Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2019 activities at the BRPP BABs CCR unit (2019 Annual Report).

The groundwater sampling results were below background limits for Appendix III indicator parameters during both the March and October 2018 semiannual monitoring events; therefore, no statistically significant increases (SSIs) were reported for the Belle River Power Plant Bottom Ash Basins (BRPP BABs) CCR unit. As such, DTE Electric continued detection monitoring at the BRPP BABs CCR Unit in 2019 pursuant to §257.94 of the CCR Rule. This 2019 Annual Report presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the March and September 2019 semiannual groundwater monitoring events for the BRPP BABs CCR unit. Detection monitoring for these events continued to be performed in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin* (QAPP) (TRC, July 2016; revised August 2017) and statistically evaluated per the Stats Plan (TRC, October 2017). As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify SSIs of detection monitoring parameters compared to background levels.

1.2 Site Overview

The BRPP is located in Section 13, Township 4 North, Range 16 East, at 4505 King Road, China Township in St. Clair County, Michigan. The BRPP was constructed in the early 1980s with plant operations beginning in 1984. Prior to Detroit Edison Company's operations commencing in the 1980s, the BRPP property was generally wooded and farmland. The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984 and is generally constructed over a natural clay-rich soil base. The BABs have been in use with the BRPP since it began operation and have collected CCR bottom ash that is periodically cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The BRPP BABs are two adjacent physical sedimentation basins that are slightly raised CCR surface impoundments referred to as the North and South BABs, located north of the BRPP. These are considered one CCR unit. The BABs receive sluiced bottom ash and other process flow water from the power plant. Discharge water from each BAB flows over an outlet weir that gravity flows to a site storm water conveyance network of ditches and pipes, then flows into the diversion basin (DB) CCR unit, which is monitored as a separate CCR unit in accordance with the CCR Rule and addressed in a separate 2019 Annual Report.

The DB is an incised CCR surface impoundment located east of the BRPP. Water flows into the DB from the North and South BABs through a network of pipes and ditches. The DB discharges to the St. Clair River with other site wastewater in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.3 Geology/Hydrogeology

The BRPP BABs CCR unit is located approximately one-mile west of the St. Clair River. The BRPP BABs CCR unit is underlain by more than 130 feet of unconsolidated sediments, with the lower confining Bedford Shale generally encountered from 135 to 145 feet below ground surface (bgs). In general, the BRPP BABs CCR unit is initially underlain by at least 90 to as much as 136 feet of laterally extensive low hydraulic conductivity silty clay-rich deposits. The depth to the top of the confined sand-rich uppermost aquifer encountered immediately beneath the silty clay-rich deposits varies up to 46 feet within the monitoring well network and rapidly thins to the south and east of the BABs and pinches out (e.g., no longer present) to the southeast in the vicinity of SB-16-01 (Figure 1). Consequently, the uppermost aquifer is not laterally contiguous across the entire BRPP BABs CCR unit, and not present beneath the southeastern corner of the BABs.

The variability in the depth to the uppermost aquifer is a consequence of the heterogeneity of the glacial deposits and is driven by the lateral discontinuity of the sand outwash within the encapsulating fine-grained, silty clay till that confines the uppermost aquifer. There is an apparent lack of interconnection and/or significant vertical variation between the uppermost aquifer sand unit(s) encountered across the BRPP BABs CCR unit as demonstrated by the extensive amount of time (months) it took for water levels in monitoring well MW-16-02 to reach equilibrium after well construction and development (TRC, 2017).

Given the horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the BRPP BABs CCR unit, the heterogeneity of the glacial deposits (with the top of the uppermost aquifer elevation across the BABs, where present varying up to 46 feet vertically), the no flow boundary where no sand or gravel is present in the southeastern portion of the BABs CCR unit area, and the apparent lack of hydraulic interconnectedness of the uppermost aquifer encountered at the BABs in some areas, it is not appropriate to infer horizontal flow direction or gradients across the BRPP BABs CCR unit.

In addition, the elevation of CCR-affected water maintained within the BRPP BABs is approximately 5 feet above the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR affected surface water in the BABs were able to penetrate the silty clay-rich underlying confining unit that the head on that release likely would travel radially away from the BABs within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the BRPP it is not possible for the uppermost aquifer to have been affected by CCR from BRPP operations that began in the 1980s.

Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, the potential for radial flow, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the BRPP BABs CCR unit using intrawell statistical methods is appropriate. In addition, because the uppermost aquifer is not uniformly present across the BABs CCR unit, there are no clear upgradient wells. As such, intrawell statistical approaches are being used during detection monitoring as discussed in the Stats Plan.

Section 2
Groundwater Monitoring

2.1 Monitoring Well Network

A groundwater monitoring system has been established for the BRPP BABs CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of five monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2.

As discussed in the Stats Plan, intrawell statistical methods for the BABs CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the variability in the presence of the uppermost aquifer across the site, and presence of no flow boundary on the southeast side of the aquifer), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). An intrawell statistical approach requires that each of the downgradient wells doubles as a background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background dataset from that same well. Monitoring wells MW-16-01 through MW-16-04 and MW-16-09 are located around the north, east and south perimeter of the BABs and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of five background/downgradient monitoring wells).

2.2 Semiannual Groundwater Monitoring

The semiannual monitoring parameters for the detection groundwater monitoring program were selected per the CCR Rule's Appendix III to Part 257 – Constituents for Detection Monitoring. The Appendix III indicator parameters consist of boron, calcium, chloride, fluoride, pH (field reading), sulfate, and total dissolved solids (TDS) and were analyzed in accordance with the sampling and analysis plan included within the QAPP. In addition to pH, the collected field parameters included dissolved oxygen, oxidation reduction potential, specific conductivity, temperature, and turbidity.

2.2.1 Data Summary

The first semiannual groundwater detection monitoring event for 2019 was performed during March 18 to 20, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all five monitoring well locations. Groundwater samples were collected from the five detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the March 2019 event is provided on Table 1 (static groundwater elevation data), Table 2 (field data), and Table 3 (analytical results).

The second semiannual groundwater detection monitoring event for 2019 was performed during September 16 to 17, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all five monitoring well locations. Groundwater samples were collected from the five detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the October 2018 event is provided on Table 1 (static groundwater elevation data), Table 2 (field data), and Table 4 (analytical results).

2.2.2 Data Quality Review

Data from each round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The data were found to be complete and usable for the purposes of the CCR monitoring program. Data quality reviews are summarized in Appendix B.

2.2.3 Groundwater Flow Rate and Direction

As presented in the GWMS Report, and mentioned above, given the horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the BRPP BABs CCR unit; the heterogeneity of the glacial deposits (with the top of the uppermost aquifer elevation across the BABs; where present, varying up to 46 feet vertically); the no flow boundary where no sand or gravel is present in the southeastern portion of the BRPP BABs CCR unit area; and the apparent lack of hydraulic interconnectedness of the uppermost aquifer encountered at the BABs in some areas, it is not appropriate to infer horizontal flow direction or gradients across the site. Groundwater elevations measured across the Site during the March 2019 sampling event are provided on Table 1 and are summarized in plan view on Figure 3. Groundwater elevations measured across the Site during the September 2019 sampling event are provided on Table 1 and are summarized in plan view on Figure 4.

Groundwater elevation data collected during the 2019 sampling events show that groundwater conditions within the uppermost aquifer are consistent with previous monitoring events and continue to demonstrate that the downgradient wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the BRPP BABs CCR unit.

Section 3
Statistical Evaluation

3.1 Establishing Background Limits

Per the Stats Plan, background limits were established for the Appendix III indicator parameters following the collection of at least eight background monitoring events using data collected from each of the five established detection monitoring wells (MW-16-01 through MW-16-04 and MW-16-09). The statistical evaluation of the background data is presented in the 2017 Annual Report. The Appendix III background limits for each monitoring well will be used throughout the detection monitoring period to determine whether groundwater has been impacted from the BRPP BABs CCR unit by comparing concentrations in the detection monitoring wells to their respective background limits for each Appendix III indicator parameter.

3.2 Data Comparison to Background Limits – First Semiannual Event (March 2019)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04 and MW-16-09) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth).

The comparisons of the March 2019 monitoring event data to background limits are presented on Table 3. The statistical evaluation of the March 2019 Appendix III indicator parameters showed potential initial SSIs over background for:

- Total dissolved solids (TDS) at MW-16-01; and
- Sulfate at MW-16-04.

3.3 Verification Resampling for the First Semiannual Event

Verification resampling is recommended per the Stats Plan and the *USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (Unified Guidance, USEPA, 2009) to achieve performance standards as specified by §257.93(g) in the CCR Rule. Per the Stats Plan, if there is an exceedance of a prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Only constituents that initially exceed their statistical limit (i.e., have no previously recorded SSIs) will be analyzed for verification purposes.

Verification resampling for the March 2019 event was conducted on May 9, 2019 by TRC personnel. Groundwater samples were collected for total dissolved solids at MW-16-01 and sulfate at MW-16-04, In accordance with the QAPP. A summary of the analytical results collected during the May 2019 resampling event is provided on Table 3. The associated data quality review is included in Appendix A.

The verification results for TDS (MW-16-01) and sulfate (MW-16-04) are above the prediction limits, consequently the initial potential SSIs from the March 2019 event are confirmed at these locations.

According to §257.94(e), in the event that the facility determines, pursuant to §257.93(h), that there is a SSI over background levels for one or more of the Appendix III constituents, the facility will, within 90 days of detecting a SSI, demonstrate that a source other than the CCR unit caused the SSI, or the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. If an alternate source demonstration (ASD) is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under §257.95. If an ASD is completed, a certification from a qualified professional engineer is required, and the CCR unit may continue with detection monitoring. The facility must also include the ASD in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

DTE Electric prepared an ASD dated August 8, 2019, *Alternate Source Demonstration: 2019 First Semi Annual Detection Monitoring Sampling Event Bell River Power Plant Coal Combustion Residual Bottom Ash Basins* (April 2019 ASD). This ASD demonstrates that the SSIs confirmed above are from natural variability in groundwater quality and not from a release of the BRPP BABs CCR unit and is provided in Appendix A. As such, detection monitoring continued at the BRPP BABs CCR unit in 2019.

3.4 Data Comparison to Background Limits – Second Semiannual Event (September 2019)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04 and MW-16-09) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth).The comparisons of the September 2019 monitoring event are presented on Table 4. The statistical evaluation of the September 2019 Appendix III indicator parameters showed potential initial SSIs over background for:

- Calcium at MW-16-03;

- Chloride at MW-16-03; and
- Sulfate at MW-16-04

The sulfate concentration at MW-16-04 is a continued exceedance of the prediction limit that has been demonstrated to be from natural variability and is not from a release from the CCR unit as presented in the August 2019 ASD (Appendix A).

3.5 Verification Resampling for the Second Semiannual Event

Verification resampling for the September 2019 event was conducted on November 11, 2019 by TRC personnel. Groundwater samples were collected for calcium and chloride at MW-16-03, in accordance with the QAPP. A summary of the analytical results collected during the November 2019 resampling event is provided on Table 4. The associated data quality review is included in Appendix B.

The calcium and chloride verification results are below the prediction limits, consequently the initial potential SSIs from the September 2019 event are not confirmed. Therefore, in accordance with the Stats Plan and the Unified Guidance, the initial exceedances are not statistically significant, and no SSIs will be recorded for the September 2019 monitoring event.

Section 4
Conclusions and Recommendations

Potential SSIs over background limits were noted for a few Appendix III constituents in one or more downgradient wells during the March and September 2019 monitoring events. These potential SSIs were either not statistically significant (i.e. verification sampling did not confirm the exceedance) or were evaluated and determined to be a result of natural variability in groundwater quality as documented in an ASD (Appendix A) and not attributable to the BRPP BABs CCR unit. As discussed above and in the GWMS Report, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the BRPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from operations. In addition, due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer. Therefore, detection monitoring will be continued at the BRPP BABs CCR unit in accordance with §257.94. No corrective actions were performed in 2019. The next semiannual monitoring event is scheduled for the second calendar quarter of 2020.

Section 5
Groundwater Monitoring Report Certification

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.90(e) requires that the owner or operator of an existing CCR unit prepare an annual groundwater monitoring and corrective action report.

Annual Groundwater Monitoring Report Certification
Belle River Power Plant Bottom Ash Basins
China Township, Michigan

CERTIFICATION

I hereby certify that the annual groundwater and corrective action report presented within this document for the BRPP BABs CCR unit has been prepared to meet the requirements of Title 40 CFR §257.90(e) of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.90(e).

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2021	State of Michigan David B. McKenzie Engineer No. 42332 Licensed Professional Engineer
Company: TRC Engineers Michigan, Inc.	Date: January 30, 2020	Stamp

Section 6
References

TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company Belle River Power Plant Coal Combustion Residual Bottom Ash Basins, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. January 2018. Annual Groundwater Monitoring Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. April 12, 2018. Alternate Source Demonstration: 2017 Initial Detection Monitoring Sampling Event Belle River Power Plant Coal Combustion Residual Bottom Ash Basins. Prepared for DTE Electric Company.

TRC Environmental Corporation. August 8, 2019. Alternate Source Demonstration: 2019 First Semi Annual Detection Monitoring Sampling Event Belle River Power Plant Coal Combustion Residual Bottom Ash Basins. Prepared For DTE Electric Company.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA facilities, Unified Guidance. Office of Conservation and Recovery. EPA 530/R-09-007.

USEPA. April 2015. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 80 Federal Register 74 (April 17, 2015), pp. 21301-21501 (80 FR 21301).

USEPA. July 2018. 40 CFR Part 257. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One); Final Rule. 83 Federal Register 146 (July 30, 2018), pp. 36435-36456 (83 FR 36435).

USEPA. April 2018. Barnes Johnson (Office of Resource Conservation and Recovery) to James Roewer (c/o Edison Electric Institute) and Douglas Green, Margaret Fawal

(Venable LLP). Re: Coal Combustion Residuals Rule Groundwater Monitoring Requirements. April 30, 2018. United States Environmental Protection Agency, Washington, D.C. 20460. Office of Solid Waste and Emergency Response, now the Office of Land and Emergency Management.

Tables

Table 1
Summary of Groundwater Elevation Data – March and September 2019
Belle River Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
China Township, Michigan

Well ID	MW-16-01		MW-16-02		MW-16-03		MW-16-04		MW-16-09	
Date Installed	3/17/2016		3/15/2016		6/1/2016		3/8/2016		6/2/2016	
TOC Elevation	590.06		588.94		590.66		590.51		590.80	
Geologic Unit of Screened Interval	Sand		Sand		Silty Sand		Sand		Sand	
Screened Interval Elevation	496.3 to 491.3		494.3 to 489.3		456.0 to 451.0		468.5 to 463.5		452.3 to 447.3	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
3/18/2019	15.88	574.18	13.40	575.54	16.27	574.39	16.64	573.87	16.46	574.34
9/16/2019	15.88	574.18	13.38	575.56	16.16	574.50	16.53	573.98	16.35	574.45

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet Below top of casing.

Table 2
Summary of Field Data – March and September 2019
Belle River Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-01	3/18/2019	0.17	-134.9	7.6	1,822	10.30	2.42
	9/16/2019	0.16	-172.1	7.6	1,614	13.44	2.06
MW-16-02	3/18/2019	1.34	-116.3	7.6	1,428	10.90	2.13
	9/16/2019	0.33	-167.1	7.5	1,267	15.49	1.57
MW-16-03	3/18/2019	1.14	-163.4	7.9	2,088	10.50	1.13
	9/16/2019	0.16	-194.2	7.6	1,840	14.89	0.96
MW-16-04	3/18/2019	1.34	-168.7	7.9	1,899	10.00	45.3
	9/16/2019	0.14	-211.2	7.8	1,676	16.06	50.2
MW-16-09	3/20/2019	1.17	-237.8	8.0	2,933	10.80	68.7
	9/17/2019	0.14	21.1	8.0	2,994	14.34	120

Notes:
mg/L - milligrams per liter.
mV - milliVolt.
SU - standard unit.
umhos/cm - micro-mhos per centimeter.
deg C - degrees Celcius.
NTU - nephelometric turbidity units.

Table 3
Comparison of Appendix III Parameter Results to Background Limits – March and May 2019
Belle River Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
China Township, Michigan

Sample Location:		MW-16-01			MW-16-02		MW-16-03		MW-16-04			MW-16-09	
Sample Date:		3/18/2019	5/9/2019(1)	PL	3/18/2019	PL	3/18/2019	PL	3/18/2019	5/9/2019(1)	PL	3/20/2019	PL
Constituent	Unit	Data			Data		Data		Data			Data	
Appendix III													
Boron	ug/L	1,200	--	1,300	1,200	1,300	1,200	1,300	1,000	--	1,100	1,600	1,900
Calcium	ug/L	41,000	--	45,000	54,000	59,000	33,000	36,000	42,000	--	64,000	32,000	41,000
Chloride	mg/L	480	--	530	370	400	570	690	500	--	520	960	1,100
Fluoride	mg/L	1.6	--	1.9	1.1	1.3	1.6	1.9	1.6	--	1.9	1.3	1.8
pH, Field	SU	7.6	7.7	7.6 - 8.1	7.6	7.4 - 8.0	7.9	7.5 - 8.3	7.9	7.7	7.5 - 8.4	8.0	7.7 - 8.7
Sulfate	mg/L	5.8	--	8.1	4.8	20	2.4	14	**27**	**24(2)**	18	18	40
Total Dissolved Solids	mg/L	**960**	**970(2)**	950	730	890	1,100	1,100	990	**--**	1,100	1,700	2,000

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a confirmed exceedance of the Prediction Limit (PL).

(1) - Results shown for verification sampling performed on 5/9/2019.

(2) - New successful alternative source demonstration was completed following confirmation of the initial statistically significant exceedance.

Table 4

Comparison of Appendix III Parameter Results to Background Limits – September and November 2019

Belle River Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program

China Township, Michigan

Sample Location:		MW-16-01		MW-16-02		MW-16-03			MW-16-04		MW-16-09	
Sample Date:		9/16/2019	PL	9/16/2019	PL	9/16/2019	11/11/2019(1)	PL	9/16/2019	PL	9/17/2019	PL
Constituent	Unit	Data		Data		Data			Data		Data	
Appendix III												
Boron	ug/L	1,000	1,300	1,100	1,300	1,100	--	1,300	1,000	1,100	1,500	1,900
Calcium	ug/L	43,000	45,000	58,000	59,000	**38,000**	20,000	36,000	47,000	64,000	37,000	41,000
Chloride	mg/L	460	530	350	400	**1,000**	600	690	480	520	920	1,100
Fluoride	mg/L	1.8	1.9	1.1	1.3	1.8	--	1.9	1.7	1.9	1.4	1.8
pH, Field	SU	7.6	7.6 - 8.1	7.5	7.4 - 8.0	7.6	7.8	7.5 - 8.3	7.8	7.5 - 8.4	8.0	7.7 - 8.7
Sulfate	mg/L	7.5	8.1	5.8	20	1.7	--	14	**20(2)**	18	12	40
Total Dissolved Solids	mg/L	950	950	770	890	1,000	--	1,100	970	1,100	1,800	2,000

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

-- = not analyzed.

All metals were analyzed as total unless otherwise specified.

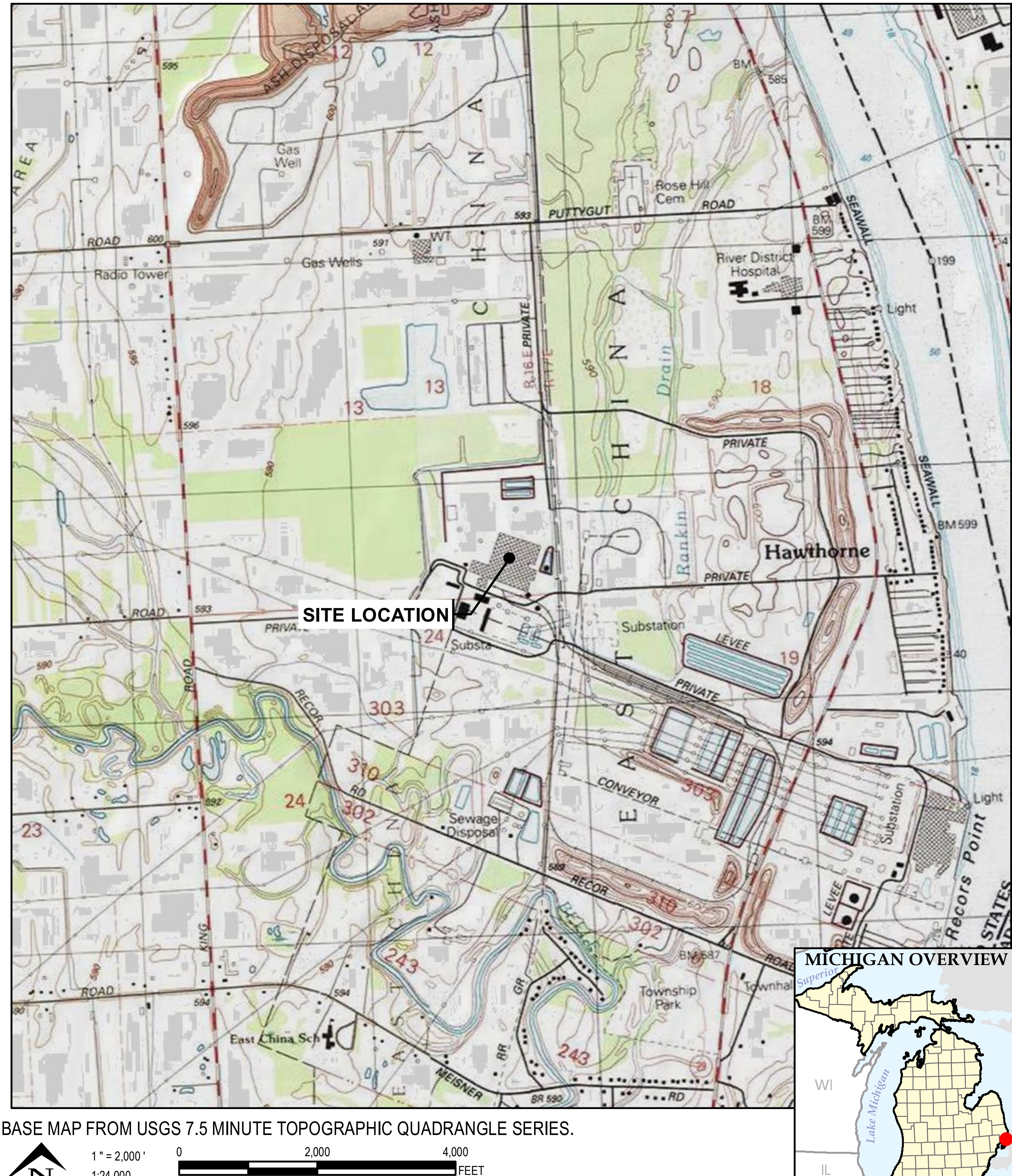
Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a confirmed exceedance of the Prediction Limit (PL).

(1) - Results shown for verification sampling performed on 11/11/2019.

(2) - Concentration addressed through first 2019 Semiannual alternative source demonstration.

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	S. MAJOR
CHECKED BY:	J. KRENZ
APPROVED BY:	V. BUENING
DATE:	JANUARY 2020
PROJ. NO.:	320511.0003
FILE:	320511-0003-003slmMB.mxd

FIGURE 1

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:	**DTE ELECTRIC COMPANY** **BELLE RIVER POWER PLANT BOTTOM ASH BASIN** **4505 KING ROAD** **CHINA TOWNSHIP, MICHIGAN**
TITLE:	**SITE PLAN**
DRAWN BY:	M. VAPHIADIS
PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	J. KRENZ
APPROVED BY:	V. BUENING
DATE:	JANUARY 2020
	FIGURE 2
FILE NO.:	320511-0003-022.mxd

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/28/2020, 08:56:04 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-022.mxd

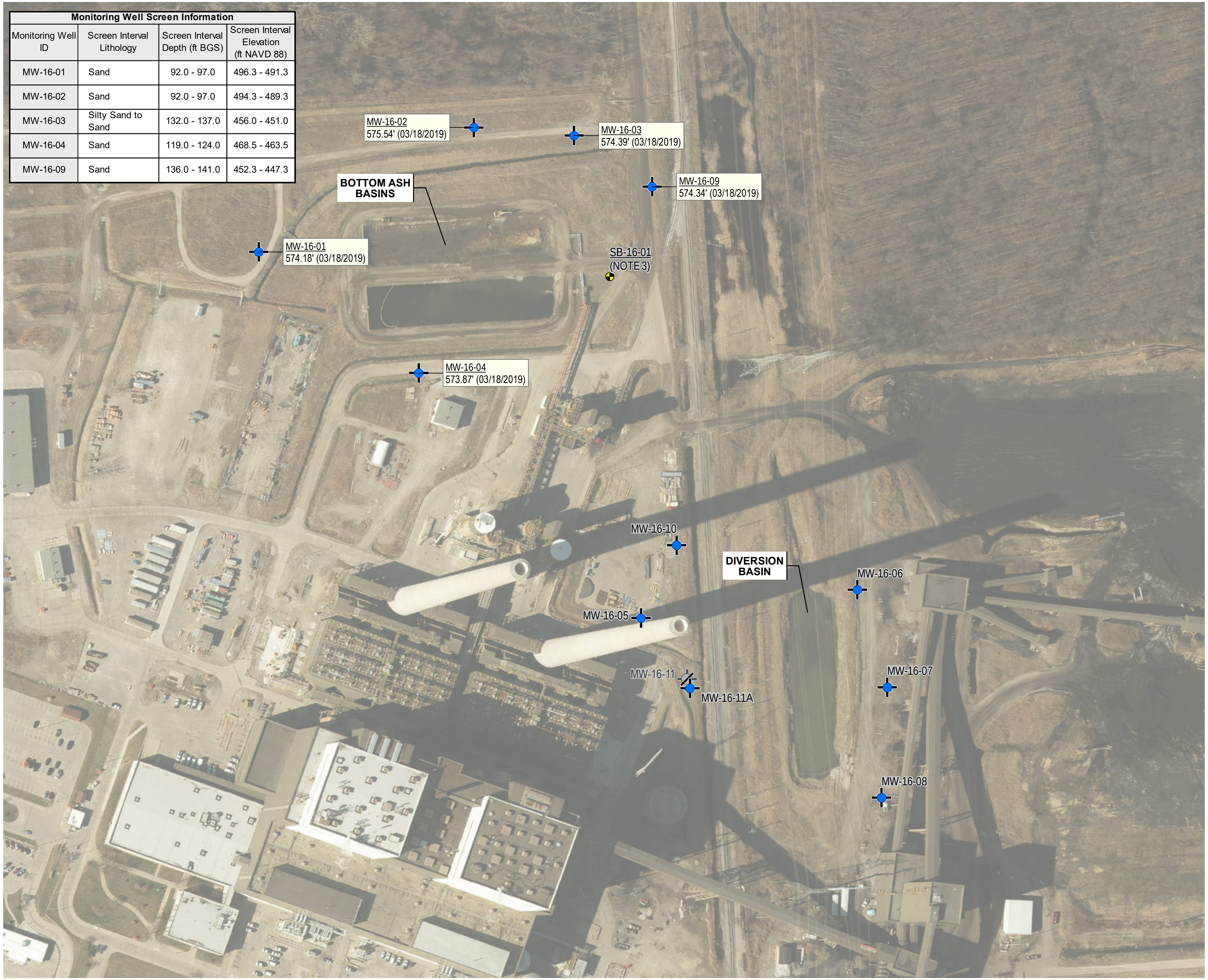
TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/28/2020, 09:00:10 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-023.mxd

Monitoring Well Screen Information

Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3



LEGEND

SOIL BORING

MONITORING WELL

DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/23/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.

N

0 200 400
Feet

1 " = 200 '
1:2,400

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
BOTTOM ASH BASINS
GROUNDWATER POTENTIOMETRIC
ELEVATION SUMMARY MARCH 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003
CHECKED BY:	J. KRENZ	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 320511-0003-023.mxd

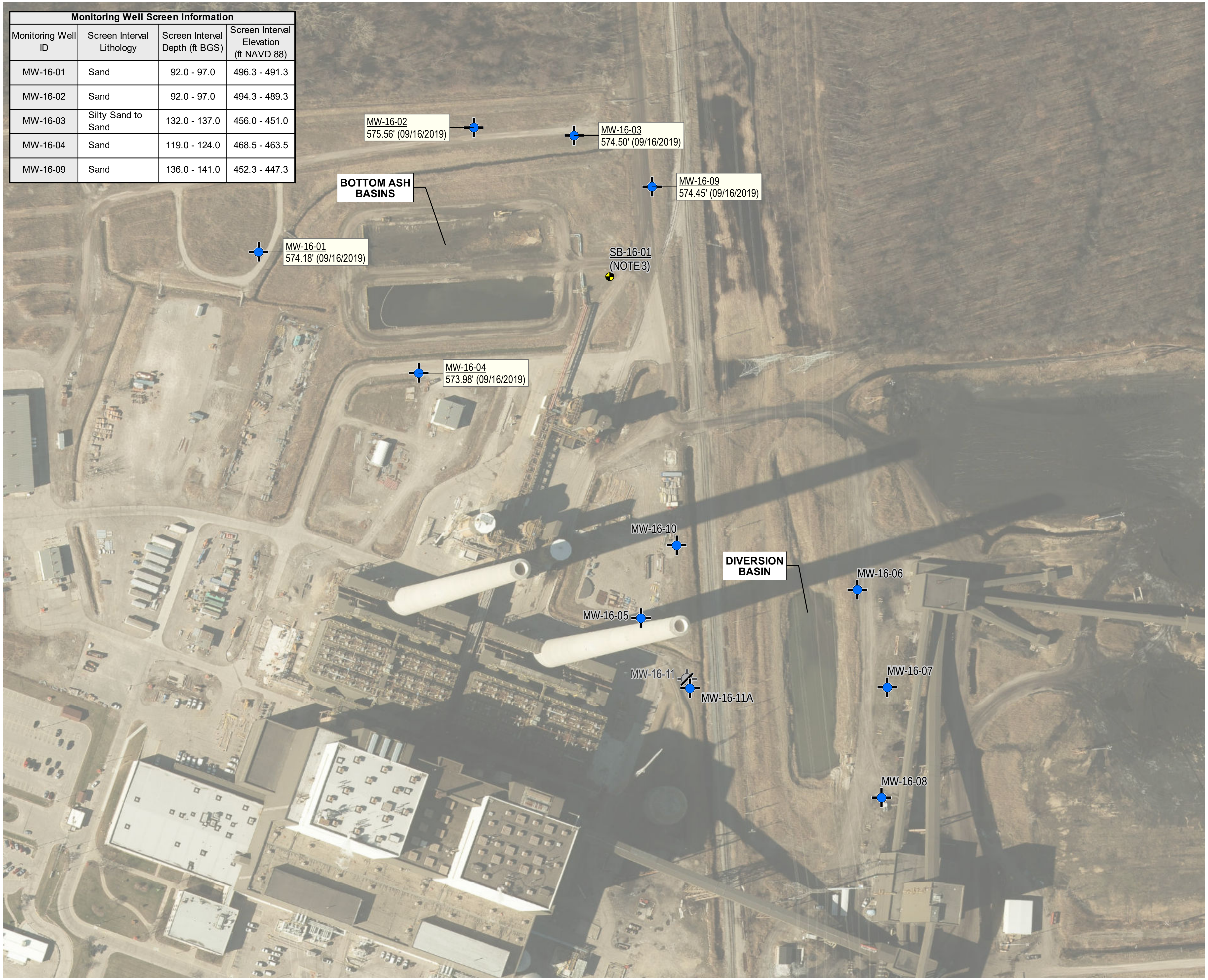
TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/28/2020, 09:03:29 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-024.mxd

Monitoring Well Screen Information

Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3



LEGEND

SOIL BORING

MONITORING

DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/23/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.

N

0 200 400 Feet

1 " = 200 '
1:2,400

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT BOTTOM ASH BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
BOTTOM ASH BASINS
GROUNDWATER POTENTIOMETRIC
ELEVATION SUMMARY SEPTEMBER 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003
CHECKED BY:	J. KRENZ		**FIGURE 4**
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 320511-0003-024.mxd

Appendix A
Alternative Source Demonstration: First 2019 Semiannual Detection Monitoring Sampling Event

1540 Eisenhower Pl.
Ann Arbor, MI 48108

T 734.971.7080
TRCcompanies.com

Technical Memorandum

Date: August 8, 2019

To: Christopher P. Scieszka
DTE Electric Company

From: Graham Crockford, TRC
David McKenzie, TRC

Project No.: 320511.0003.0000 Phase 001, Task 001

Subject: Alternate Source Demonstration: 2019 First Semi Annual Detection Monitoring Sampling Event Belle River Power Plant Coal Combustion Residual Bottom Ash Basins

Introduction

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule). The CCR Rule, which became effective on October 19, 2015, applies to the DTE Electric Company (DTE Electric) Belle River Power Plant (BRPP) CCR Bottom Ash Basins (BABs) CCR unit.

TRC Engineers Michigan, Inc. (TRC) conducted the first semiannual 2019 detection monitoring event for the BRPP BABs CCR unit on behalf of DTE Electric on March 18 through March 20, 2019 in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin* (QAPP) (TRC, July 2016; revised March and August 2017). The semiannual groundwater monitoring event included the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the BRPP BABs CCR unit. This event is the fourth detection monitoring event performed to comply with §257.94. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed background levels. The statistical analysis was performed pursuant to §257.93(f) and (g), and in accordance with the Groundwater Statistical Evaluation Plan (Stats Plan) (TRC, 2017).

The statistical evaluation of the March 2019 Appendix III indicator parameters showed potential SSIs over background for:

- Total Dissolved Solids (TDS) at MW-16-01; and
- Sulfate at MW-16-04

All other Appendix III constituents were within the statistical background limits.

In accordance with §257.94(3)(2), DTE Electric may demonstrate that a source other than the CCR unit caused the SSI or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. This Alternate Source Demonstration (ASD) has been prepared to evaluate the potential SSIs identified in the March 2019 detection monitoring event.

Background

The BRPP is located in China Township in St. Clair County, Michigan. The site location is shown in Figure 1. The BRPP was constructed in the early 1980s with plant operations beginning in 1984. The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984 and is generally constructed over a natural clay rich soil base. The BABs have been in use with the BRPP since it began operation and have collected CCR bottom ash that is periodically cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The BRPP BABs are two adjacent physical sedimentation basins that are slightly raised CCR surface impoundments referred to as the North and South BABs, located north of the BRPP. These are considered one CCR unit. The BABs receive sluiced bottom ash and other process flow water from the power plant. Discharge water from each BAB gravity flows over an outlet weir to a conveyance network of ditches and pipes, then flows into the diversion basin (DB) CCR unit, which is monitored as a separate CCR unit in accordance with the CCR Rule.

The BRPP BABs CCR unit is located approximately one-mile west of the St. Clair River. The BRPP BABs CCR unit is underlain by more than 130 feet of unconsolidated sediments, with the lower confining Bedford Shale generally encountered from 135 to 145 feet below ground surface (bgs). In general, the BRPP BABs CCR unit is initially underlain by at least 90 to as much as 136 feet of laterally extensive low hydraulic conductivity silty clay-rich deposits. The depth to the top of the confined sand-rich uppermost aquifer encountered immediately beneath the silty clay-rich deposits varies up to 46 feet within the monitoring well network and rapidly thins to the south and east of the BABs and pinches out (e.g., no longer present) to the southeast. Consequently, the uppermost aquifer is not laterally contiguous across the entire BRPP BABs CCR unit, and not present in the southeastern corner of the BABs.

The detection monitoring well network for the BABs CCR unit currently consists of five monitoring wells that are screened in the uppermost aquifer. As discussed in the Stats Plan, intrawell statistical methods for the BABs CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the variability in the presence of the uppermost aquifer across the site, and presence of no flow boundary on the southeast side of the aquifer), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). Monitoring wells MW-16-01 through MW-16-04 and MW-16-09 are located around the north, east and south perimeter of the BABs and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of five background/downgradient monitoring wells). The monitoring well locations are shown in Figure 2. The *Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units*, (GWMS Report) details the groundwater monitoring system (TRC, October 2017).

Alternate Source Demonstration

Verification resampling was performed as recommended per the Stats Plan and the USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (Unified Guidance, USEPA, 2009) to achieve performance standards as specified by §257.93(g) in the CCR rules. Per the Stats Plan, if there is an exceedance of a prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Only constituents that initially exceed their statistical limit (i.e., have no previously recorded SSIs) will be analyzed for verification purposes. As such, verification resampling was conducted on May 9, 2019, by TRC personnel. Groundwater samples were collected for TDS at monitoring well MW-16-01 and sulfate at monitoring well MW-16-04 in accordance with the Quality Assurance Project Plan (TRC, July 2016, revised in March and August 2017). A summary of the groundwater data collected during the verification resampling event is provided on Table 1. The associated data quality review is included in Attachment A.

The verification resampling confirmed the TDS exceedance at MW-16-01 and the sulfate exceedance at MW-16-04 during the May 2019 verification sampling event. The following discussion presents the ASD for the confirmed prediction limit exceedances.

TDS at MW-16-01: The TDS concentrations at MW-16-01, shown graphically as data points greater than the prediction limit in Figure 3, are likely the result of natural spatial variability in groundwater quality at the site and a statistical false positive, and not the result of a release from the BRPP BABs CCR unit. Multiple lines of evidence are provided in support of this conclusion and are as follows:

- **Spatial variability in groundwater quality** – After 8 background sampling events, the prediction limits calculated for each of the 5 monitoring wells range from 890 mg/L to 2,000 mg/L. This variability in groundwater quality across the site, shows that the TDS concentrations vary spatially throughout the uppermost aquifer and suggests the confirmed TDS SSI at MW-16-01 could be attributed to spatial variability rather than the CCR unit.
- **Insufficient background sampling timeline to account for long-term trends** – Variability in TDS concentrations observed in the groundwater at BRPP BABs CCR unit during the background sampling events provides evidence of the heterogeneity of this constituent in groundwater. The short duration of the background sampling events limits the ability of the statistical analysis to capture the natural temporal trends in the groundwater quality at the BRPP BABs CCR unit. This is a limitation of the CCR Rule implementation timeline.

- **Lack of similar increase in other indicator parameters** – The lack of SSIs for any other parameters within the same monitoring well, and across the other wells within the monitoring well network, also suggests a source other than CCR leachate for the observed TDS SSI at this location.
- **Time of travel analysis** – The clay formation immediately beneath the BRPP BABs CCR unit provides a natural geologic barrier to migration of CCR constituents to the underlying aquifer. The vertical extent of the clay layer beneath the CCR unit is shown in Figures 6 and 7 as cross-sections. Figure 5 shows the cross-section locations in plan view. Conservatively calculating a time of travel for liquid from the base of the BRPP BABs CCR unit through a minimum of 82 feet of clay, to the underlying upper aquifer, yields approximately 1,300 years of travel time (TRC, October 2017). The BRPP BABs CCR unit began accepting coal ash in approximately 1984, so, based on this analysis, there is no potential for indicator parameters to have migrated to the upper aquifer.

Sulfate at MW-16-04: The sulfate concentrations at MW-16-04, shown graphically as data points greater than the prediction limit in Figure 4, are likely the result of natural spatial variability in groundwater quality at the site and a statistical false positive, and not the result of a release from the BRPP BABs CCR unit. Multiple lines of evidence are provided in support of this conclusion and are as follows:

- **Spatial variability in groundwater quality** – After 8 background sampling events, the prediction limits calculated for each of the 5 monitoring wells range from 8.1 mg/L to 40 mg/L. This variability in groundwater quality across the site, shows that the sulfate concentrations vary spatially throughout the uppermost aquifer and suggests the confirmed sulfate SSI at MW-16-04 could be attributed to spatial variability rather than the CCR unit.
- **Insufficient background sampling timeline to account for long-term trends** – Variability in sulfate concentrations observed in the groundwater at BRPP during the background sampling events provides evidence of the heterogeneity of this constituent in groundwater. The short duration of the background sampling events limits the ability of the statistical analysis to capture the natural temporal trends in the groundwater quality at the BRPP. This is a limitation of the CCR Rule implementation timeline.
- **Lack of similar increase in other indicator parameters** – The lack of SSIs for any other parameters within the same monitoring well, and across the other wells within the monitoring well network, also suggests a source other than CCR leachate for the observed sulfate SSI at this location.
- **Time of travel analysis** – The clay formation immediately beneath the BRPP BABs CCR unit provides a natural geologic barrier to migration of CCR constituents to the underlying aquifer. The vertical extent of the clay layer beneath the CCR unit is shown in Figures 6 and 7 as cross-sections. Figure 5 shows the cross-section locations in plan view. Conservatively calculating a time of travel for liquid from the base of the BRPP BABs CCR unit through a minimum of 82 feet of clay, to the underlying upper aquifer, yields approximately 1,300 years of travel time (TRC, October 2017). The BRPP BABs CCR unit began accepting coal ash in approximately 1984, so,

based on this analysis, there is no potential for indicator parameters to have migrated to the upper aquifer.

Conclusions and Recommendations

The information provided in this report serves as the ASD for the DTE Electric BRPP BABs CCR unit, was prepared in accordance with 40 CFR 257.94(e)(2) of the CCR Rule, and demonstrates that the TDS SSI and sulfate SSI determined based on the first semiannual detection monitoring event performed in 2019 are not due to a release of CCR leachate into the groundwater. Therefore, based on the information provided in this ASD, DTE Electric will continue detection monitoring as per 40 CFR 257.94 at the BRPP BABs CCR unit.

Certification Statement

I hereby certify that the alternative source demonstration presented within this document for the BRPP BAB CCR unit has been prepared to meet the requirements of Title 40 CFR §257.94(e) 2 of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.94(e) 2.

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2019	State of Michigan David B. McKenzie Engineer No. 42332 Licensed Professional Engineer
Company: TRC Engineers Michigan, Inc.	Date: 8/8/19	Stamp

References

TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company Belle River Power Plant Coal Combustion Residual Bottom Ash Basins, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA facilities, Unified Guidance. Office of Conservation and Recovery. EPA 530/R-09-007.

Attachments

Table 1. Comparison of Verification Sampling Results to Background Limits

Figure 1. Site Location Map
Figure 2. Monitoring Network and Site Plan
Figure 3. MW-16-01 TDS Time Series Plot
Figure 4. MW-16-04 Sulfate Time Series Plot
Figure 5. Cross Section Locator Map
Figure 6. Generalized Geologic Cross-Section A-A’
Figure 7. Generalized Geologic Cross-Section B-B’

Attachment A. Data Quality Review

Table 1

Table 1

Comparison of Verification Sampling Results to Background Limits
Belle River Power Plant BABs - RCRA CCR Monitoring Program
China Township, Michigan

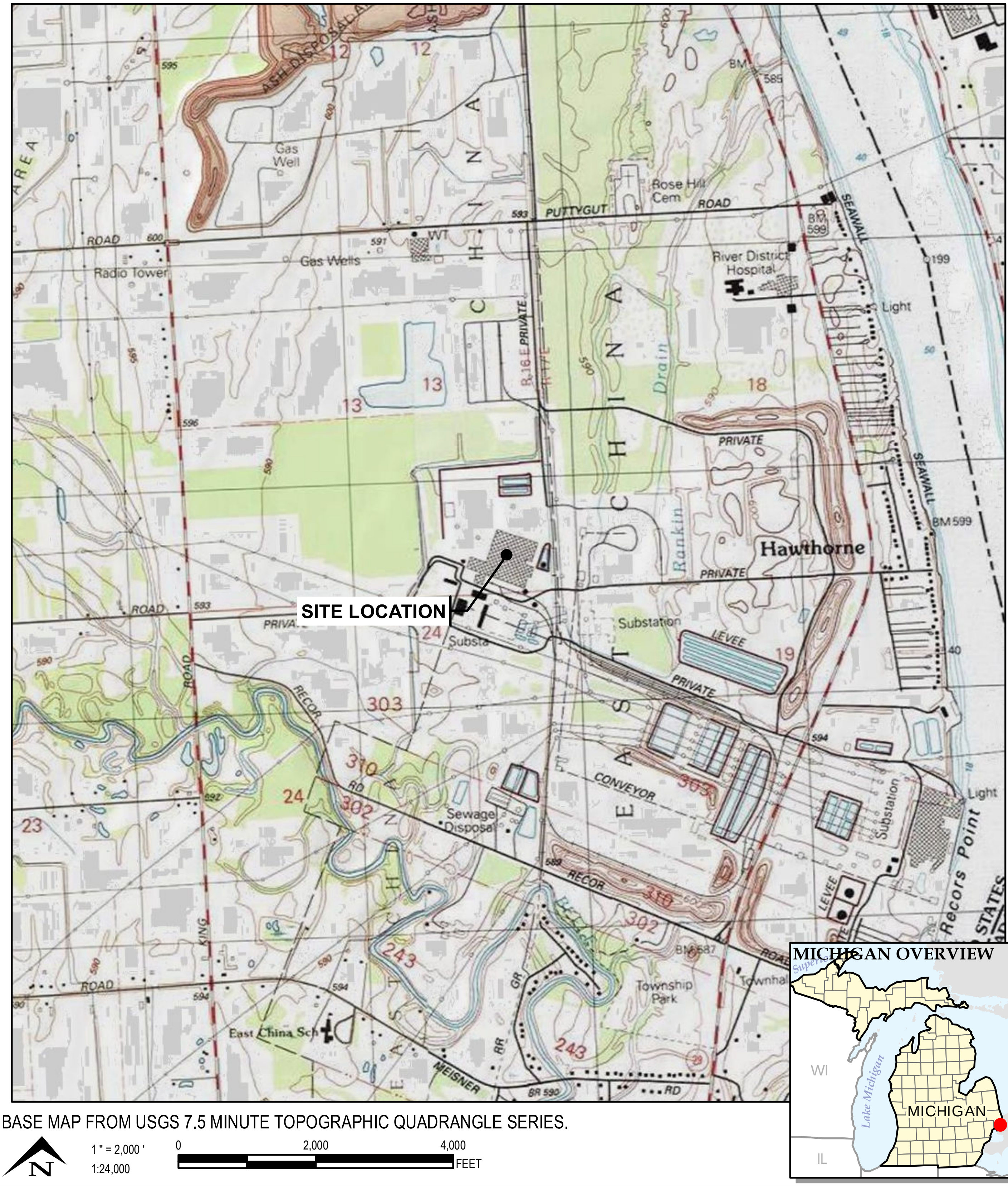
	Sample Location:	**MW-16-01**		**MW-16-04**	
	Sample Date:	5/9/2019		5/9/2019	
Constituent	Unit	Data	PL	Data	PL
Appendix III					
Sulfate	mg/L	--	8.1	**24**	18
Total Dissolved Solids	mg/L	**970**	950	--	1,100

Notes:

mg/L - milligrams per liter.

RESULT Shading and bold font indicates a confirmed exceedance of the Prediction Limit (PL).

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
TRC - GIS

PROJECT:	DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN
TITLE:	SITE LOCATION MAP

DRAWN BY:	J PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V BUENING
DATE:	AUGUST 2019
PROJ. NO.:	320511.0003.0000 P1 T1
FILE:	320511-0003-001slmMB.mxd

FIGURE 1

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	R SUEMNICHT	PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	S HOLMSTROM	**FIGURE 2**	
APPROVED BY:	V BUENING		
DATE:	AUGUST 2019		

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 320511-0003-004.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 8/6/2019, 12:43:33 PM by AADAIR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-004.mxd

Figure 3
MW-16-01 TDS Time Series Plot
Belle River Power Plant Bottom Ash Basins - RCRA CCR Monitoring Program

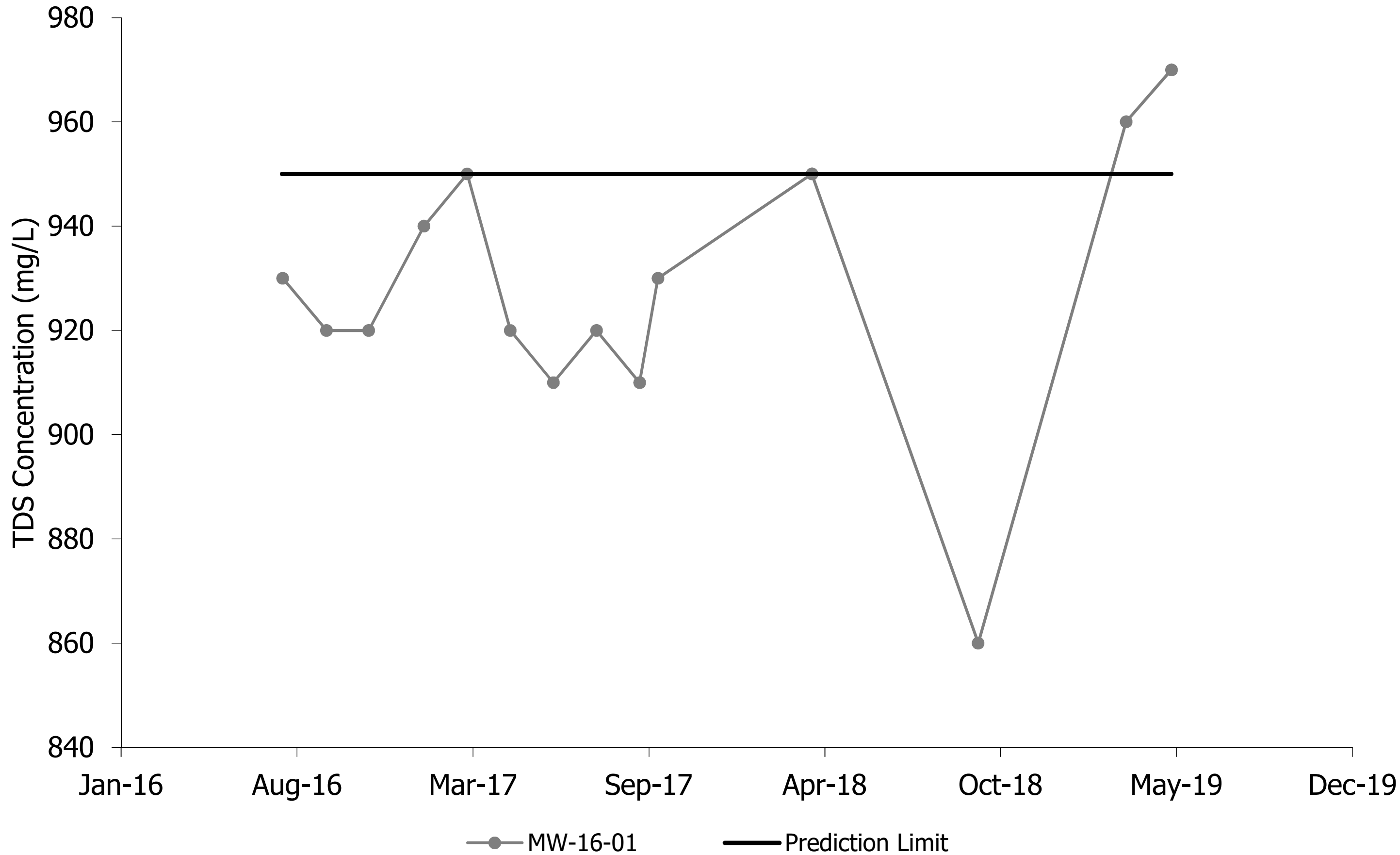
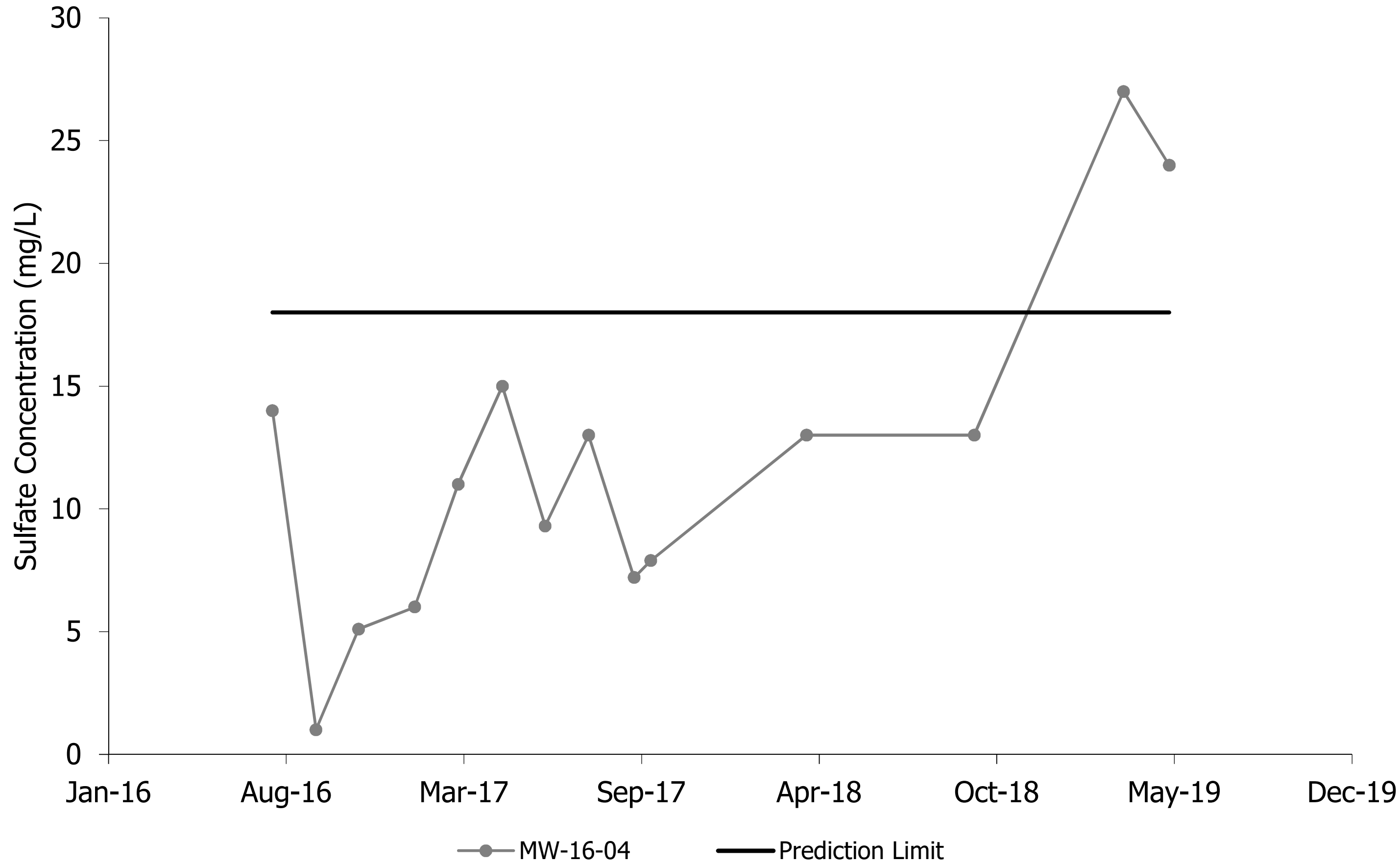


Figure 4
MW-16-04 Sulfate Time Series Plot
Belle River Power Plant Bottom Ash Basins - RCRA CCR Monitoring Program



LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:	DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN		
TITLE:	CROSS SECTION LOCATOR MAP		
DRAWN BY:	J. PAPEZ	PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	S. HOLMSTROM		FIGURE 5
APPROVED BY:	V. BUENING		
DATE:	AUGUST 2019		
FILE NO.:	320511-0003-011.mxd		

TRC

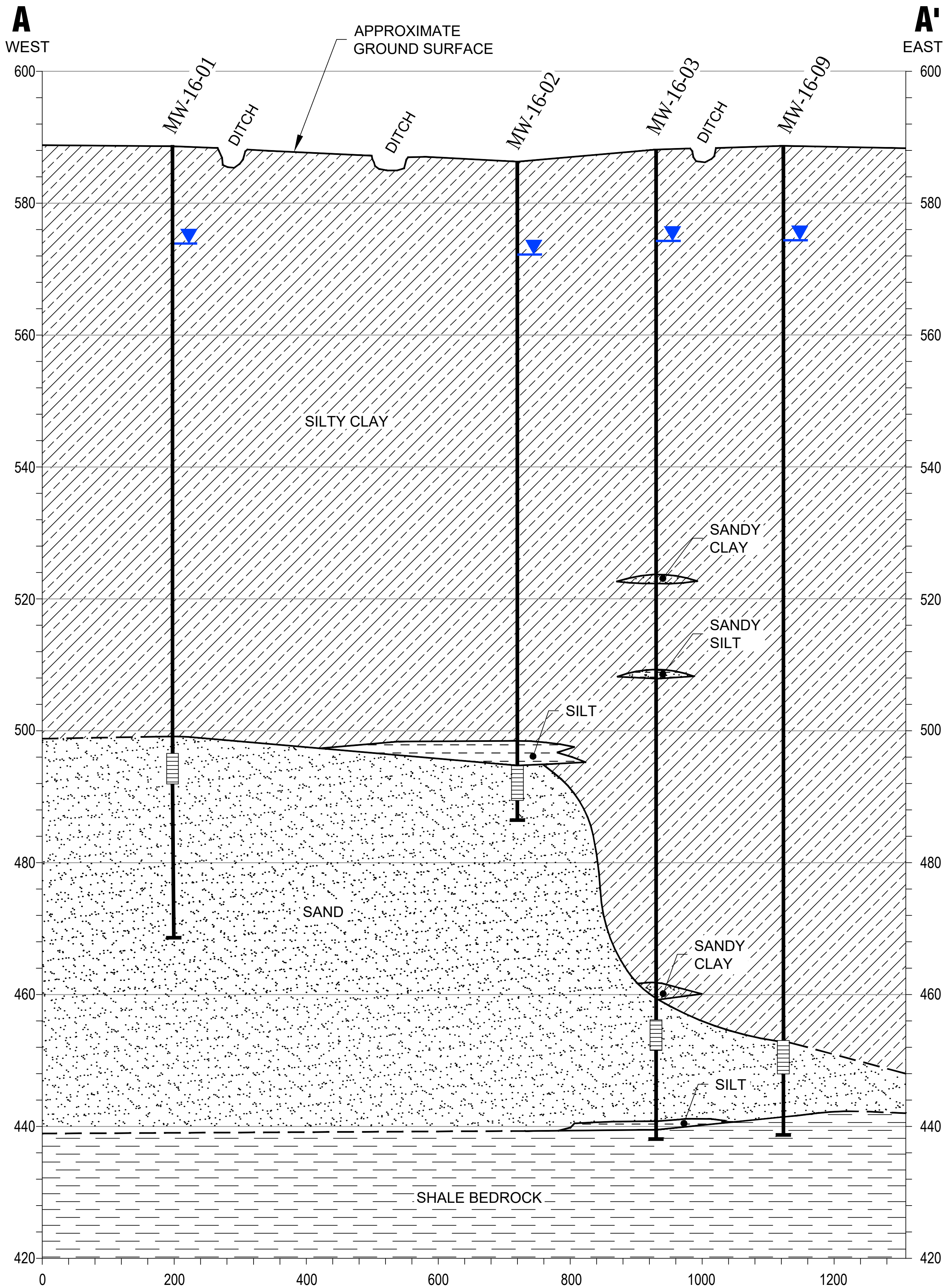
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 8/7/2019, 08:32:15 AM by AADAIR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0003-011.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
SOIL BORING
WELL SCREEN INTERVAL
END OF BORING

Lithology Key

SILTY CLAY
SAND
SILT
SANDY CLAY
SANDY SILT
SHALE BEDROCK

SCALE IN FEET
VERTICAL 0 20
HORIZONTAL 0 200

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

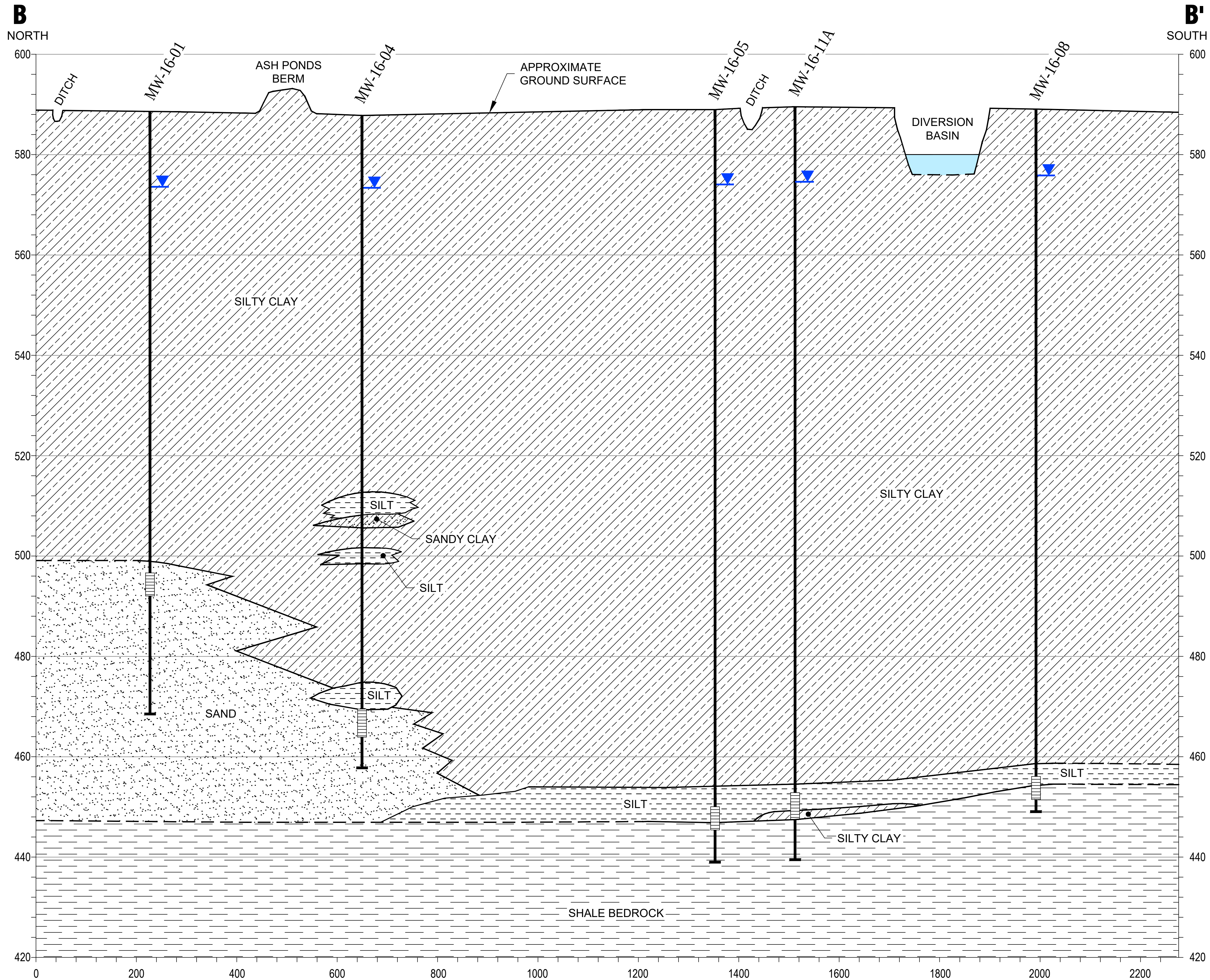
DRAWN BY:	D.STEHLE	PROJ NO.:	320511.0003.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 6**	
APPROVED BY:	V.BUENING		
DATE:	AUGUST 2019		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 320511.0003.01.01.06-07.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\Belle River PP\320511\0003\01\01\320511.0003.01.01.06-07.dwg --- PLOT DATE: August 07, 2019 - 9:42AM --- LAYOUT: FIG06 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



LEGEND

- STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

Lithology Key

- SILTY CLAY
- SAND
- SILT
- SANDY CLAY
- SHALE BEDROCK

SCALE IN FEET
VERTICAL 0 – 20
HORIZONTAL 0 – 200

PROJECT:	DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT CHINA TOWNSHIP, MICHIGAN
TITLE:	GENERALIZED GEOLOGIC CROSS-SECTION B-B'
DRAWN BY: D.STEHLE	PROJ NO.: 320511.0003.01.01
CHECKED BY: S.HOLMSTROM	FIGURE 7
APPROVED BY: V.BUENING	
DATE: AUGUST 2019	
TRC	1540 Eisenhower Place Ann Arbor, MI 48108 Phone: 734.971.7080 www.trcsolutions.com
FILE NO.:	320511.0003.01.01.06-07.dwg

Attachment A
Data Quality Review

Laboratory Data Quality Review
Groundwater Monitoring Event May 2019 (Verification Resampling)
DTE Electric Company Belle River Power Plant (DTE BRPP)

On May 9, 2019, TRC Environmental Corporation (TRC) collected groundwater samples at MW-16-01 and MW-16-04 to verify analytical results that were outside of the prediction limits during the March 2019 detection monitoring event. Samples were analyzed by Test America Laboratories, Inc. (Test America), located in Canton, Ohio for anions (SW846 6020/9056A) and total dissolved solids (TDS) (SM 2540C). The laboratory analytical results are reported in laboratory report J112501-1.

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Data for method blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures;
- Reporting limits (RLs) compared to project-required RLs;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for laboratory duplicates. The laboratory duplicates are replicate analyses of one sample and are used to assess the precision of the analytical method; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

QA/QC Sample Summary:

- Target analytes were not detected in associated method blanks.
- LCS recoveries were within laboratory control limits.
- Dup-01 corresponds with MW-16-01 and Dup-02 corresponds with MW-16-04; relative percent differences (RPDs) between the parent and duplicate sample were within the QC limits.
- Data are usable for purposes of verification sampling.

Appendix B
Data Quality Reviews

Laboratory Data Quality Review
Groundwater Monitoring Event March 2019 (Detection Monitoring)
DTE Electric Company Belle River Power Plant (DTE BRPP)

Groundwater samples were collected by TRC for the March 2019 sampling event for the Diversion Basin at the DTE BRPP. Samples were analyzed for anions, boron, calcium, and total dissolved solids by Test America Laboratories, Inc., (Test America) located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-109798-1.

During the March 2019 sampling event, a groundwater sample was collected from the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04
- MW-16-05
- MW-16-06
- MW-16-07
- MW-16-08
- MW-16-09
- MW-16-10
- MW-16-11A

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;

- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS.MSDs), if applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, if applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- The reviewed constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- The holding time for TDS for samples MW-16-01, MW-16-02, MW-16-03, MW-16-04, MW-16-05, DUP-01, and EB-01 exceeded the 7-day holding time criteria by approximately 5-10 hours. These results are estimated and may be biased low.
- Target analytes were not detected in the equipment blank (EB-01_20190318).
- Target analytes were not detected in the method blanks.
- LCS recoveries for all target analytes were within laboratory control limits.
- Sample DUP-01 corresponds with sample MW-16-01. The relative percent differences (RPDs) between the parent and duplicate sample were within the acceptance limits.
- Laboratory duplicate analyses were performed on sample MW-16-01 for TDS; the RPD was within the acceptance limits.

- MS/MSD analyses were performed on the following samples:
  - Sample MW-16-01 for boron; the percent recoveries (%Rs) and RPDs were within the acceptance limits.
  - Samples MW-16-02 and DUP-01 for fluoride and sulfate; the %Rs and RPDs were within the acceptance limits.
  - Sample MW-16-02 for calcium; the MS/MSD %Rs (68%/63%) were below the lower QC limit of 75%, but no action was required since the sample result in the parent sample was > 4x the spike added.
- For TDS, the constant weight was not achieved after three drying cycles for sample MW-16-02; there was no impact on data usability.

Laboratory Data Quality Review
Groundwater Monitoring Event September 2019 (Detection Monitoring)
DTE Electric Company Belle River Power Plant (DTE BRPP)

Groundwater samples were collected by TRC for the September 2019 sampling event for the Bottom Ash Basins and Diversion Basin at the DTE BRPP. Samples were analyzed for anions, total boron, total calcium, and total dissolved solids by Eurofins-Test America Laboratories, Inc. (Eurofins-TA), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-119135-1.

During the September 2019 sampling event, a groundwater sample was collected from each of the following wells:

Bottom Ash Basins:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04
- MW-16-09

Diversion Basin:

- MW-16-05
- MW-16-06
- MW-16-07
- MW-16-08
- MW-16-10
- MW-16-11A

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;

- Data for method blanks and equipment blanks, where applicable. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS/MSDs), where applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, where applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- There was one equipment blank submitted with this dataset (EB-01) which was associated with the low hydraulic conductivity wells (MW-16-08, MW 16-10, and MW-16-11A). Chloride was detected at 1.8 mg/L and TDS was detected at 12 mg/L in this equipment blank. However, these analytes were detected at concentrations greater than five times the blank concentrations in the associated wells; thus, there was no impact on data usability.

- Target analytes were not detected in the method blanks.

- LCS recoveries for all target analytes were within laboratory control limits.

- MS/MSD analyses were performed on samples MW-16-01 for boron, MW-16-03 for fluoride and sulfate, and MW-16-02 for calcium; the percent recoveries (%Rs) and relative percent differences (RPDs) were acceptable.
  - MS/MSD analyses were not performed for chloride; per the project QAPP, MS/MSD analyses are required for chloride at a frequency of 1 per 20 samples. It is likely that an MS/MSD was performed on sample MW-16-03 for chloride but not reported by the laboratory since the sample was re-analyzed at a dilution for chloride.

- Laboratory duplicate analyses were not performed for TDS. Per the project QAPP, laboratory duplicate analyses are required for TDS at a frequency of 1 per 20 samples.

- Dup-01 corresponds with MW-16-01; RPDs between the parent and duplicate sample were within the QC limits.

- The nondetect reporting limits (5.0 mg/L) for sulfate in samples MW-16-06, MW-16-08, and MW-16-11A were above the QAPP-specified RL (1.0 mg/L) due to a 5-fold dilution which was likely the result of elevated chloride concentrations.

Laboratory Data Quality Review
Groundwater Monitoring Event
November Verification (Detection Monitoring)
DTE Electric Company Belle River Power Plant (DTE BRPP)

One groundwater sample was collected by TRC for the November 2019 sampling event for the Bottom Ash Basin at the DTE BRPP. The sample was analyzed for calcium and chloride by Test America Laboratories, Inc. (Test America), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-122291-1

During the November 2019 sampling event, a groundwater sample was collected from the following well:

Bottom Ash Basin:

- MW-16-03

The sample was analyzed for the following constituents:

Analyte Group	Method
Chloride	SW846 9056A
Total Recoverable Calcium	SW846 3005A/6020

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS/MSDs). The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;

- Data for laboratory duplicates. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Target analytes were not detected in the method blanks.

- LCS recoveries for all target analytes were within laboratory control limits.

- MS/MSD analyses were not performed on the sample in this data set.

- DUP-01_20191111 corresponds with MW-16-03_20191111; the RPD between the parent and duplicate sample were within the QC limits for chloride; the RPD of 51.9% exceeded the QC limits for calcium and potential uncertainty exists for calcium in all groundwater samples, as summarized in the attached table, Appendix B.

Appendix B
Owner Certification of Compliance

Owner Certification of Site Compliance per 40 CFR 257 Subpart D
Belle River Power Plant Bottom Ash Basins
China Township, Michigan

The United States Environmental Protection Agency (EPA) Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments (40 CFR §257.71(d)), requires that the owner of an existing CCR unit certify the facility is in compliance with the requirements of the CCR Rules (40 CFR 257 Subpart D) except for §257.71(a)(1).

CERTIFICATION

Based on our review of the CCR Rules, I hereby certify that the subject facility is in compliance with the requirements of 40 CFR 257 Subpart D except for §257.71(a)(1).

SIGNATURE ______________________ DATE ______________________

PRINT NAME ______________________ TITLE ______________________

COMPANY NAME ______________________

Appendix C
Well Construction Diagrams and Soil Boring Logs

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-01

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	2/29/16	2/29/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.17	591.30	120.0	6/4

Boring Location:	Personnel	Drilling Equipment:
Approximately 188 feet off road to the S, W of bottom ash basins. N: 471155.70 E: 13625546.02	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/13/16 08:45 Depth (ft bgs) 14.52

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				SILTY CLAY WITH GRAVEL mostly clay, little to some silt, little fine to coarse gravel, few fine sand, low plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well. Original boring abandoned due to compromised screen. Redrilled and installed at survey location noted above within 10 feet of original location.
1 CS	60		5	**CLAY** mostly clay, trace fine to coarse gravel, high plasticity, brown (10YR 5/3), moist, stiff. Change to dark gray (10YR 4/1), very stiff at 5.0 feet. Change to soft at 8.0 feet.	CL			
			10	Change to no gravel, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very soft at 10.0 feet.				
2 CS	50		15					
			20	Change to dark gray (10YR 4/1) at 20.0 feet.				
3 CS	100		25					
			30					
4 CS	100		35					
			40					

Signature: [signature]

Checked By: C. Scieszka

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-01

SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, soft.				
6 ST	100		50					
7 CS	100		55					
			60					
8 CS	80		65		CL			
			70					
9 CS	100		75					
			80					
10 CS	100		85					
			90	**SAND** mostly fine sand, dark gray (10YR 4/1), saturated.				
11 CS	100		95		SP			
			100	End of boring at 100.0 feet below ground surface.				

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/14/16	3/15/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	586.27	588.94	100.0	6/4

Boring Location:	Personnel	Drilling Equipment:
325 feet W of haul road, 5 feet N of road, N of bottom ash basins. N: 471409.06 E: 13625991.78	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/13/16 09:24 ▼ Depth (ft bgs) 16.07

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			0	**CLAY** mostly clay, few silt, few coarse gravel, medium plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	80		5					
				Change to no gravel at 7.0 feet.				
			10	Change to high plasticity, dark gray (10YR 4/1), moist, very soft at 10.0 feet.				
2 CS	80		15	▼				
			20		CL			
3 CS	100		25					
			30					
4 CS	90		35					
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-02

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 CS	100		50–55	**SILTY CLAY** mostly clay, little to some silt, few fine sand, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1), very soft.	CL-ML			
7 CS	50		60–65					
8 CS	100		70–75					
9 CS	100		80–85					
			90	**CLAYEY SILT** mostly silt, some clay, few fine sand, few coarse gravel, low plasticity, dark gray (10YR 4/1), moist, very soft.	ML-CL			
10 CS	100		95	**SAND** mostly fine to coarse sand, dark gray (10YR 4/1), saturated. Change to fine sand at 96.0 feet.	SW			
			100	End of boring at 100.0 feet below ground surface.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-03

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	5/25/16	5/31/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.03	590.66	150.0	6/4

Boring Location:	Personnel	Drilling Equipment:
Approximately 100 feet W of haul road, N of bottom ash basins. N: 471391.78 E: 13626202.49	Logged By - J. Reed Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 6/8/16 14:30 ▼ Depth (ft bgs) 12.82

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				TOPSOIL				
1 CS	100		5	**SILTY CLAY** mostly clay, some silt, few fine to medium sand, trace gravel, low to medium plasticity, dark gray (10YR 4/1) with trace orange mottling, moist, medium stiff to stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10	Change to gray (10YR 5/1) at 10.5 feet.				
2 CS	100		15	▼ **CLAY** mostly clay, few silt, trace to few fine to medium sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.	CL			
			20					
3 CS	100		25	Change to trace to few fine to coarse sand at 25.0 feet.				
			30					
4 CS	100		35					
			40	Change to trace fine to coarse sand at 41.5 feet.				

Signature: [signature] | Firm: TRC Environmental Corporation, 1540 Eisenhower Place Ann Arbor, Michigan | 734.971.7080 Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, trace fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.	CL			
			50					
6 CS	90		55					
			60	Change to stiff at 60.5 feet.				
7 CS	100			Change to medium stiff at 62.0 feet.				
			65	**SANDY CLAY** mostly clay, little to some sand, few silt, gray (10YR 5/1), moist, soft to medium stiff.	CL			
				CLAY mostly clay, few silt, few fine to coarse sand, gray (10YR 5/1), moist, stiff. Change to coal fragments present at 67.5 feet. Change to no coal fragments present at 68.0 feet.	CL			
			70					
8 CS	90		75	1-inch thick interval of silty fine to coarse sand at 75.0 feet.				
				SANDY SILT mostly silt, little to some fine to medium sand, gray (10YR 5/1), moist, medium dense.	ML			
			80	**CLAY** mostly clay, few silt, few fine to coarse sand, low to medium plasticity, gray (10YR 5/1), moist, stiff.	CL			
9 CS	100		85					
			90	Change to medium soft at 90.0 feet.				
10 CS	100		95	Change to few fine gravel from 94.0 to 95.0 feet. Change to trace fine gravel, medium stiff to stiff at 95.0 feet.				
			100					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY** mostly clay, few silt, few fine to coarse sand, trace fine gravel, medium plasticity, gray (10YR 5/1), medium stiff to stiff.				
12 CS	100		110 / 115	Change to low plasticity, soft to medium stiff at 111.0 feet.	CL			
13 CS	100		120 / 125					
				SANDY CLAY mostly clay, little to some fine to medium sand, few silt, trace to few fine gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff.	CL			
14 CS	90		130	**SILTY SAND** mostly fine to medium sand, little silt, gray (10YR 5/1), moist, loose.	SM			
			135	**SAND** mostly fine to medium sand, trace silt, gray (10YR 5/1), moist, loose.	SP			
				SILTY SAND mostly fine to medium sand, little silt, few clay, gray (10YR 5/1), moist, loose.	SM			
15 CS	100		140 / 145	**SAND** mostly fine to coarse sand, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.	SW			
				SILT mostly silt, few clay, trace coarse sand to fine gravel, gray (10YR 5/1), dry to moist, dense to very dense.	ML			
			150	**SHALE** weathered shale bedrock, dark gray.				
				End of boring at 150 feet below ground surface.				
			155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-04

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/7/16	3/8/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	587.50	590.51	130.0	6/4

Boring Location: 200 feet from W corner of road, S of bottom ash basins.
N: 470893.74 E: 13625876.34

Personnel
Logged By - A. Knutson
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/13/16 09:31 ▼ Depth (ft bgs) 13.91

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			0	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very stiff. Change to no gravel at 1.0 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	80		5					
			10	Change to stiff at 10.5 feet.				
				Change to dark gray (10YR 4/1), very soft at 12.0 feet.				
			▼ 13.91					
2 CS	100		15					
			20					
3 CS	100		25					
			30					
4 CS	100		35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Checked By: C. Scieszka

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			
			50					
6 CS	100		55					
			60	Change to few coarse gravel at 60.0 feet.				
7 CS	100		65					
			70					
8 CS	100			**SILTY CLAY** mostly clay, little to some silt, trace fine sand, medium plasticity, dark gray (10YR 4/1), very stiff.	CL-ML			
			75	**SILT** mostly silt, trace to few fine sand, non plastic, dark gray (10YR 4/1), saturated, stiff.	ML			
			80	**SAND** mostly fine sand, few medium to coarse sand, dark gray (10YR 4/1), moist.	SP			
				SANDY CLAY mostly clay, some fine sand, high plasticity, dark gray (10YR 4/1), moist.	CL			
9 CS	100		85	**SILTY CLAY** mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.	CL-ML			
				CLAYEY SILT mostly silt, some clay, low plasticity, dark gray (10YR 4/1), stiff.	ML-CL			
			90	**SILTY CLAY** mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.	CL-ML			
10 CS	100		95					
			100	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				CLAY mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			
11 CS	100		105					
			110					
12 CS	100			**SILT** mostly silt, few fine sand, nonplastic, dark gray (10YR 4/1), saturated, stiff.	ML			
			115					
				SAND mostly fine sand, dark gray (10YR 4/1), saturated.	SP			
13 CS	100		120					
			125					
			130	End of boring at 130.0 feet below ground surface.				
			135					
			140					
			145					
			150					
			155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-05

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/3/16	3/4/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.32	590.82	150.0	6

Boring Location:	Personnel	Drilling Equipment:
S end of haul road, W of diversion basin. N: 470378.15 E: 13626342.79	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/13/16 09:55 ▼ Depth (ft bgs) 14.37

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				CLAY WITH GRAVEL mostly clay, few to some coarse gravel, high plasticity, dark grayish brown (10YR 4/2), moist, very stiff.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	80		5	**CLAY** mostly clay, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, hard. Change to no gravel, very stiff at 4.0 feet.				
			10	Change to dark gray (10YR 4/1), very soft at 10.0 feet.				
2 CS	100		15	▼				
			20		CL			
3 CS	100		25	Change to medium stiff at 26.0 feet. Change to very soft at 28.0 feet.				
			30					
4 CS	100		35					
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
				SILTY CLAY mostly clay, little to some silt, medium plasticity, dark gray (10YR 4/1), very soft.	CL-ML			
6 ST	100		50	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
7 CS	100		55					
8 CS	100		60	Change to few fine to coarse gravel at 60.0 feet.				
			65	Change to medium stiff at 65.0 feet.				
				Change to stiff at 67.5 feet.				
9 CS	100		70	**SILTY CLAY** mostly clay, some silt, few fine to coarse gravel, high plasticity, very dark gray (10YR 3/1), very stiff.	CL-ML			
			75	Change to low plasticity, black (10YR 2/1), hard at 77.0 feet.				
10 CS	60		80					
			85	Change to few to little fine sand at 85.5 feet.				
11 CS	100		90	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
				Change to medium stiff at 93.5 feet.				
			95	Change to soft at 97.5 feet.				
			100					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
12 CS	100		105	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL	
			110			
13 CS	100		115			
			120			
14 CS	100		125			
			130			
15 CS	100		135	**CLAYEY SILT** mostly silt, some clay, medium plasticity, dark gray (10YR 4/1), wet, medium stiff.	ML-CL	
			140	**SHALE** dark gray (10YR 4/1), dry.		
16 CS	90		145			
			150	End of boring at 150.0 feet below ground surface.		
			155			

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-06

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/10/16	3/11/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.98	593.21	140.0	6

Boring Location:	Personnel	Drilling Equipment:
123 feet S of road connecting to haul road, E of diversion basin. N: 470439.03 E: 13626796.04	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/13/16 10:01 Depth (ft bgs) 14.45

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, some fine to coarse sand, brown (10YR 5/3), moist, dense.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				CLAY mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.				
1 CS	50		5					
			10	Change to few coarse gravel at 10.0 feet.				
				Change to dark gray (10YR 4/1), stiff at 12.0 feet. Change to very soft at 13.0 feet.				
2 CS	100		15					
			20					
					CL			
3 CS	100		25					
			30					
4 CS	100		35					
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-06

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
			50					
6 CS	100		55					
			60					
7 CS	100		65					
			70	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
				SAND mostly fine sand, few coarse sand, dark gray (10YR 4/1), moist.	SP			
8 CS	100		75	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
			80					
9 CS	80		85					
			90	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
10 CS	70		95					
			100					

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-06

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS; 12 CS; 13 CS	100; 100; 100		105, 110, 115, 120	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
13 CS			125, 130	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
14 CS	100		135	**SILT** mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
				SHALE dark gray (10YR 4/1), hard, brittle.				
			140	End of boring at 140.0 feet below ground surface.				
			145, 150, 155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-07

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/8/16	3/9/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.89	592.58	140.0	6

Boring Location:	Personnel	Drilling Equipment:
326 feet S of road connecting to haul road, E of diversion basin. N: 470233.47 E: 13626858.79	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/13/16 11:56 Depth (ft bgs) 14.13

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			0	**CLAY** mostly clay, few coarse gravel, high plasticity, brown (10YR 5/3) mottled with dark gray (10YR 4/1), very stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	60		5	Change to dark gray (10YR 4/1) mottled with brown (10YR 5/3) at 5.0 feet.				
			10	Change to dark gray (10YR 4/1) at 11.0 feet.				
2 CS	100		13	Change to moist, very soft at 13.0 feet.				
			15					
			20		CL			
3 CS	100		25					
			30					
4 CS	100		35					
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 ST	100		50					
7 CS	100		55	**SILTY CLAY** mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
			60					
8 CS	100			**CLAYEY SILT** mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML-CL			
			65	**SAND** mostly fine to coarse sand, dark gray (10YR 4/1), moist, loose.	SW			
				CLAYEY SILT mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML-CL			
			70	**SILTY CLAY** mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft. Change to few coarse gravel at 70.0 feet.	CL-ML			
9 CS	100		75					
			80					
10 CS	100		85					
			90					
11 CS	100		95					
			100					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				SILTY CLAY mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
12 CS	100		105					
			110					
13 CS	80		115					
			120					
14 CS	100		125					
			130					
				SILT mostly silt, no plasticity, dark gray (10YR 4/1), saturated, loose.	ML			
				SHALE dark gray (10YR 4/1), brittle, hard.				
15 CS	100		135					
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-08

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/9/16	3/10/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.31	591.88	140.0	6

Boring Location: 566.6 feet S of road connecting to haul road, E of diversion basin. N: 470002.90 E: 13626846.85	Personnel: Logged By - A. Knutson; Driller - A. Goldsmith	Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs); After Drilling: Date/Time 4/13/16 12:00 ▼ Depth (ft bgs) 13.19

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				CLAY WITH GRAVEL mostly clay, little coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	50		5	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.				
			10	Change to dark gray (10YR 4/1), very soft at 10.0 feet.				
			▼					
2 CS	100		15					
			20					
3 CS	100		25		CL			
			30					
4 CS	100		35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
			50					
6 CS	100		55					
			60					
7 CS	80		65					
			70	**SILTY CLAY** mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
8 CS	100		75					
			80					
9 CS	100		85					
			90					
10 CS	60		95					
			100					

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				SILTY CLAY mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.				
11 CS	100		105	Change to few fine sand at 105.5 feet.				
			110	Change to no sand at 110.0 feet.				
12 CS	100		115		CL-ML			
			120					
13 CS	100		125					
			130					
				SILT mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
14 CS	100		135	**SHALE** dark gray (10YR 4/1), brittle, hard.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-09

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/1/16	6/1/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.28	590.80	150.0	6

Boring Location:	Personnel	Drilling Equipment:
E of bottom ash basins, E of haul road. N: 471284.45 E: 13626365.84	Logged By - J. Reed Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 6/9/16 15:13 ▼ Depth (ft bgs) 14.36

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				TOPSOIL				
				SILTY CLAY mostly clay, little to some silt, few fine to coarse sand, trace to few fine gravel, low plasticity, dark grayish brown (10YR 4/2), moist, stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	75		5	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft.				
			10					
2 CS	85		15	▼				
			20					
3 CS	100		25		CL			
			30	Change to trace to few fine gravel at 30.0 feet.				
4 CS	100		35					
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			45	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, soft.				
5 CS	100		50	Change to soft to medium stiff at 50.0 feet.				
			55					
			60					
			65					
6 CS	100		70	Change to soft at 70.0 feet.	CL			
			75					
			80	Change to medium stiff to stiff at 80.0 feet.				
			85	Change to stiff at 85.0 feet.				
7 CS	100		90					
			95					
			100					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
8 CS	75		105	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, stiff. Change to medium stiff at 105.0 feet.	CL			
			110					
9 CS	80		115					
			120					
			125					
10 CS	100		130					
			135	**SAND** mostly fine sand, trace silt, dark gray (10YR 4/1), moist, loose.	SP			
			140	**SAND WITH GRAVEL** mostly fine to coarse sand, little to some fine to medium gravel, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.	SW			
11 CS	80		145	**SHALE** weathered, gray (10YR 5/1), brittle.				
			150	End of boring at 150.0 feet below ground surface.				
			155					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-10

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/2/16	6/3/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.25	592.26	150.0	6

Boring Location: S end of haul road, W/NW of diversion basin.	Personnel	Drilling Equipment:
N: 470532.54 E: 13626417.00	Logged By - J. Reed Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 6/9/16 07:45 ▼ Depth (ft bgs) 15.30

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				TOPSOIL				
				CLAY mostly clay, few silt, trace to few fine to coarse sand, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	50		5					
			10					
				Change to gray (10YR 5/1) at 11.0 feet. Change to soft to medium stiff at 12.0 feet.				
2 CS	90		15 ▼					
			20					
					CL			
3 CS	95		25	Change to soft at 25.0 feet.				
			30	Change to few fine to coarse sand, medium stiff at 30.0 feet.				
				Change to dark gray (10YR 4/1) at 32.0 feet.				
4 CS	100		35	Change to soft at 35.0 feet.				
			40					

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, dark gray (10YR 4/1), moist, soft.	CL			
			50					
6 CS	100		55					
			60					
7 CS	100		65					
			70	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, trace gravel, dark gray (10YR 4/1), moist, very stiff.	CL			
8 CS	100		75	Change to few to little medium to coarse sand, low to medium plasticity, stiff at 75.0 feet.				
			80	**CLAYEY SAND** mostly fine to coarse sand, some clay, dark grayish brown (10YR 4/2), moist, medium dense.	SC			
9 CS	100		85	**SAND** mostly fine to medium sand, dark grayish brown (10YR 4/2), moist, loose.	SP			
			90	**SANDY CLAY** mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			
10 CS	100		95					
			100	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			

SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			
			110	**SANDY CLAY** mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff.	CL			
12 CS	100			**SAND** mostly medium to coarse sand, dark gray (10YR 4/1), moist, loose.	SP			
			115	**CLAY** mostly clay, little sand, few to little silt, dark gray (10YR 4/1), moist, stiff.	CL			
			120					
13 CS	95		125					
			130					
14 CS	95		135					
			140					
15 CS	50		145	**GRAVELLY SILT** mostly silt, some fine to coarse gravel, few clay, few sand, low to medium plasticity, dark gray (10YR 4/1), moist, soft.	ML			
				SILTY CLAY hard, dark gray (10YR 4/1), hardpan, brittle.	CL-ML			
			150	**SHALE** dark gray.				
				End of boring at 150.0 feet below ground surface.				
			155					
			160					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-11

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/3/16	6/6/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.03	591.54	150.0	6

Boring Location: S of haul road, W of diversion basin.	Personnel	Drilling Equipment:
N: 470251.34 E: 13626438.92	Logged By - J. Reed Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 6/21/16 07:45 ▼ Depth (ft bgs) 14.47

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				TOPSOIL				
				CLAY mostly clay, few silt, trace to few sand, few gravel, low to medium plasticity, dark grayish brown (10YR 4/2), moist, stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
1 CS	50		5					
				Change to trace gravel at 8.0 feet.				
			10					
				Change to gray (10YR 5/1) at 12.0 feet.				
				Change to no gravel at 13.0 feet.				
2 CS	70		15					
			20					
				Change to medium stiff at 21.0 feet.	CL			
3 CS	90		25					
			30					
4 CS	90		35	Change to soft to medium stiff at 34.5 feet.				
			40					

Signature: [signature] Firm: TRC Environmental Corporation 734.971.7080
1540 Eisenhower Place Ann Arbor, Michigan Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	90		45	**CLAY** mostly clay, few silt, trace to few sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.	CL			
			50	Change to medium stiff at 49.0 feet.				
6 CS	100		55					
			60	Change to soft at 60.0 feet.				
7 CS	100		65					
			70	Change to trace gravel, soft to medium stiff at 70.0 feet.				
8 CS	100		75	Change to medium stiff at 75.0 feet.				
			80					
9 CS	90		85					
			90					
10 CS	90		95	Change to medium stiff to stiff at 95.0 feet.				
			100					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-11

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	85		105	**CLAY** mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff to stiff.				
12 CS	80		110	Change to medium stiff at 110.0 feet.				
			115					
13 CS	85		120		CL			
			125					
14 CS	90		130					
			135					
15 CS	90		140	**SANDY CLAY** mostly clay, some fine sand, few silt, dark gray (10YR 4/1), moist.	CL			
				CLAY mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff.	CL			
			145	**SHALE** dark gray.				
			150	End of boring 150.0 feet below ground surface.				
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-11A

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	5/11/17	5/12/17	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.5	591.66	142.0	6

Boring Location:	Personnel	Drilling Equipment:
North of fuel oil tank number 2, between berm and fence.	Logged By - J. Krenz Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 5/15/17 08:38 ▼ Depth (ft bgs) 17.79

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	90			**CLAY** mostly clay, trace gravel, medium plasticity, dark grayish brown (10YR 4/2), mottled with dark yellowish brown (10YR 4/6), medium stiff, moist, plant roots to 0.5 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10					
2 CS	60			▼				
			20	Change to high plasticity, gray (10YR 5/1), soft at 19.0 feet.				
3 CS	70							
			30					
4 CS	70							
			40					
5 CS	100							
			50					
6 CS	100							
			60					
7								

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 8/21/17

Signature: Jarl Krenz

Firm: TRC Environmental

Fax

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
CS	100			**CLAY** mostly clay, trace fine to medium gravel, high plasticity, gray (10YR 5/1), medium stiff, moist.				
			70	Change to few fine to coarse gravel at 70.0 feet.				
8 CS	100							
			80	Change to trace fine sand at 80.0 feet.				
9 CS	90							
			90					
10 CS	70							
			100		CL			
11 CS	100							
			110					
12 CS	100							
			120					
13 CS	100			Change to trace medium to coarse gravel at 126.0 feet.				
			130					
14 CS	60			**SILT** mostly silt, trace clay, dark gray (10YR 4/1), dense, saturated.	ML			
15 CS	100		140	**SILTY CLAY** mostly clay, some silt, few to little fine to coarse gravel, medium to low plasticity, dark gray (10YR 4/1), moist, medium stiff, inclusions of shale bedrock.	CL-ML			
				BEDROCK shale, weathered, gray (10YR 4/1).				
				End of boring at 142.0 feet below ground surface.				
			150					

SOIL BORING LOG

BORING NO. SB-16-01

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/1/16	3/1/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.69	---	150.0	6

Boring Location:	Personnel	Drilling Equipment:
Corner of E connecting road off haul road, E of bottom ash basins. N: 471096.38 E: 13626276.67	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time Depth (ft bgs)

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
				CLAY WITH GRAVEL mostly clay, little fine to coarse gravel, few fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff.	CL		Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to total depth.
				CLAY mostly clay, trace fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff.	CL		
1 CS	50		5				
			10	Change to stiff at 10.0 feet.			
				Change to no sand, dark gray (10YR 4/1), very soft at 13.0 feet.			
2 CS	100		15				
			20				
3 CS	100		25				
			30				
4 CS	100		35				
			40				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Checked By: M. Powers

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
6 ST	100		50				
7 CS	100		55	**CLAY WITH SAND** mostly clay, little fine to coarse sand, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
8 CS	100		60	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
			65	**SANDY SILT** mostly silt, little to some fine to coarse sand, few clay, low plasticity, dark gray (10YR 4/1), moist, stiff.	ML		
9 CS	100		70	**CLAY** mostly clay, few fine to coarse gravel, dark gray (10YR 4/1), moist, medium stiff. Change to no gravel, soft at 72.5 feet.	CL		
			75				
10 CS	100		80	Change to few coarse gravel at 80.0 feet.			
			85				
11 CS	100		90				
			95				
			100				

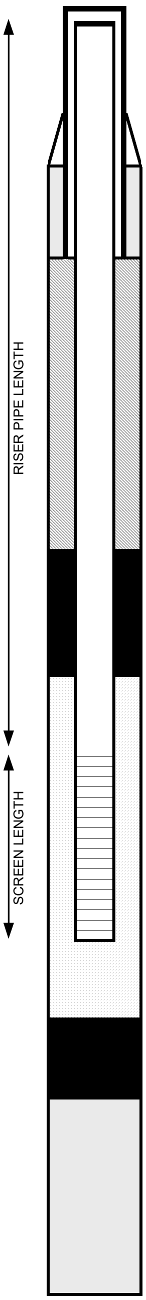
SOIL BORING LOG

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
12 CS	100		105	**CLAY** mostly clay, few coarse gravel, dark gray (10YR 4/1), moist, soft.	CL		
13 CS	100		110, 115				
14 CS	100		120, 125				
15 CS	100		130, 135	**SILT** mostly silt, few fine sand, non plastic, dark gray (10YR 4/1), moist.	ML		
16 CS	100		140, 145	**SHALE** dark gray (10YR 4/1), dry.			
			150, 155	End of boring at 150.0 feet below ground surface.			

WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: **MW-16-01**
PROJ. NO: 231828.0003	DATE INSTALLED: 3/17/2016 INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
590.06	1.8 TOP OF CASING
588.26	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
93.8	GROUT/BACKFILL METHOD: TREMIE
	84.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	89.0 BENTONITE SEAL
496.3	92.0 TOP OF SCREEN
5.00	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
491.3	97.0 BOTTOM OF SCREEN
	97.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NATURAL COLLAPSE
488.3	100.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 97 FT.; 4 IN. FROM 97 TO 100 FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.; ___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 120 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	98.20	T/PVC	3/21/2016	--
DTB AFTER DEVELOPING:	100.32	T/PVC	4/13/2016	845
SWL BEFORE DEVELOPING:	12.92	T/PVC	3/21/2016	--
SWL AFTER DEVELOPING:	16.32	T/PVC	4/13/2016	845
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

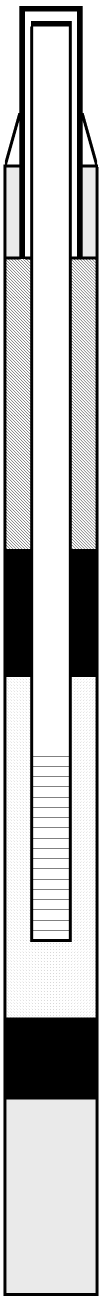
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant		WELL ID:	**MW-16-02**
PROJ. NO:	231828.0003	DATE INSTALLED: 3/15/2016 INSTALLED BY: A. Knutson		CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
588.94	2.7 TOP OF CASING
586.27	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
94.7 (RISER PIPE LENGTH)	GROUT/BACKFILL METHOD: TREMIE
	84.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	89.0 BENTONITE SEAL
494.2	92.0 TOP OF SCREEN
5.00 (SCREEN LENGTH)	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
489.2	97.0 BOTTOM OF SCREEN
	97.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NATURAL COLLAPSE
486.2	100.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 97 FT.; 4 IN. FROM 97 TO 100 FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.; ___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 460 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	97.07	T/PVC	3/15/2016	--
DTB AFTER DEVELOPING:	100.20	T/PVC	4/13/2016	9:24
SWL BEFORE DEVELOPING:	14.56	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	28.28	T/PVC	3/18/2016	--
OTHER SWL:	18.77	T/PVC	4/13/2016	9:24
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

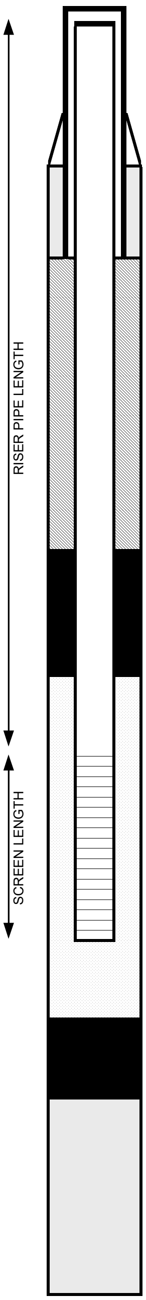
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID:	MW-16-03
PROJ. NO: 231828.0003	DATE INSTALLED: 6/1/2016	INSTALLED BY: J. Reed	CHECKED BY: M. Powers

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
590.66	2.6 TOP OF CASING
588.03	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
	GROUT/BACKFILL METHOD: TREMIE
134.5 (RISER PIPE LENGTH)	
	126.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	129.0 BENTONITE SEAL
456.2	132.0 TOP OF SCREEN
5.00 (SCREEN LENGTH)	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
451.2	137.0 BOTTOM OF SCREEN
	137.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NATURAL COLLAPSE
438.2	150.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 140 FT.; 4 IN. FROM 140 TO 150 FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.; ___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 60 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: TURBID

COLOR BEFORE: LIGHT GRAY

CLARITY AFTER: SLIGHTLY TURBID

COLOR AFTER: VERY LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	140.00	T/PVC	6/8/2016	7:20
DTB AFTER DEVELOPING:	140.00	T/PVC	6/8/2016	14:30
SWL BEFORE DEVELOPING:	16.06	T/PVC	6/8/2016	7:20
SWL AFTER DEVELOPING:	15.32	T/PVC	6/8/2016	14:30
OTHER DTB:	140.41	T/PVC	6/9/2016	10:00
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

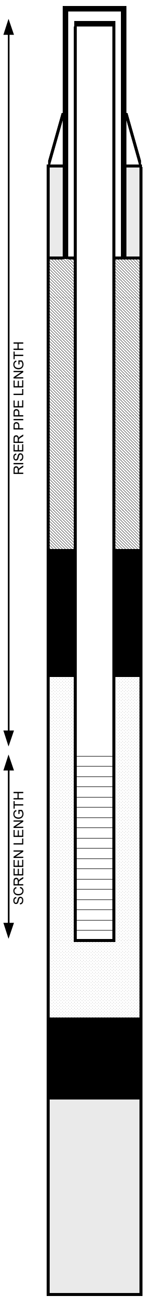
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant	WELL ID:	**MW-16-04**
PROJ. NO: 231828.0003	DATE INSTALLED: 3/8/2016	INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
590.51	3.0	TOP OF CASING
587.50	0.0	GROUND SURFACE
	1.0	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
		GROUT/BACKFILL METHOD: TREMIE
122.0		
	111.0	GROUT
		BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	116.0	BENTONITE SEAL
468.5	119.0	TOP OF SCREEN
5.00		FILTER PACK MATERIAL: MEDIUM, WASHED SAND
463.5	124.0	BOTTOM OF SCREEN
	124.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL: NATURAL COLLAPSE
457.5	130.0	HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 124 FT.; 4 IN. FROM 124 TO 130 FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.; ___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 288 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	123.97	T/PVC	3/8/2016	--
DTB AFTER DEVELOPING:	126.45	T/PVC	4/13/2016	9:31
SWL BEFORE DEVELOPING:	13.98	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	13.46	T/PVC	3/18/2016	7:30
OTHER SWL:	16.91	T/PVC	4/13/2016	9:31
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

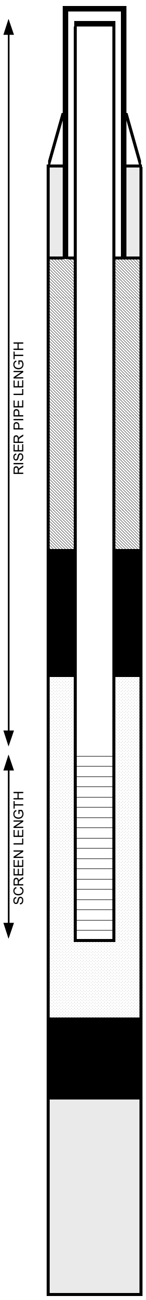
REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

TRC

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID:	**MW-16-05**
PROJ. NO: 231828.0003	DATE INSTALLED: 3/4/2016	INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
590.82	2.5 TOP OF CASING
588.32	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
141.5	GROUT/BACKFILL METHOD: TREMIE
	128.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	133.0 BENTONITE SEAL
449.3	139.0 TOP OF SCREEN
5.00	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
444.3	144.0 BOTTOM OF SCREEN
	150.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: WASHED SAND
444.3	150.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 150 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 300 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	144.03	T/PVC	3/4/2016	--
DTB AFTER DEVELOPING:	147.16	T/PVC	4/13/2016	9:55
SWL BEFORE DEVELOPING:	13.71	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	14.13	T/PVC	3/18/2016	--
OTHER SWL:	16.87	T/PVC	4/13/2016	9:55
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

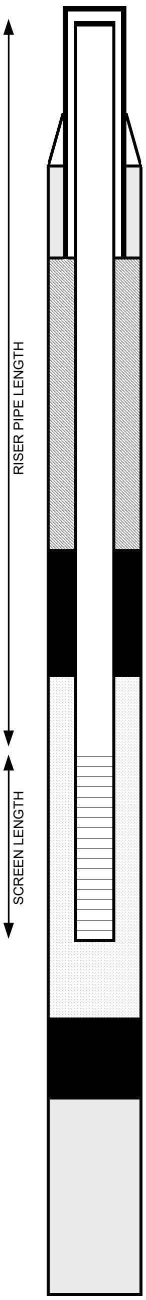
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID:	**MW-16-06**
PROJ. NO: 231828.0003	DATE INSTALLED: 3/11/2016 INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka	

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
593.21	3.2 TOP OF CASING
589.98	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
	GROUT/BACKFILL METHOD: TREMIE
138.2 (RISER PIPE LENGTH)	
	127.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	132.0 BENTONITE SEAL
455.0	135.0 TOP OF SCREEN
5.00 (SCREEN LENGTH)	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
450.0	140.0 BOTTOM OF SCREEN
	140.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NA
450.0	140.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 140 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 50 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NOT MEASURED

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	135.07	T/PVC	3/8/2016	--
DTB AFTER DEVELOPING:	142.85	T/PVC	4/13/2016	10:01
SWL BEFORE DEVELOPING:	19.62	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	14.90	T/PVC	3/18/2016	7:30
OTHER SWL:	17.65	T/PVC	4/13/2016	10:01
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

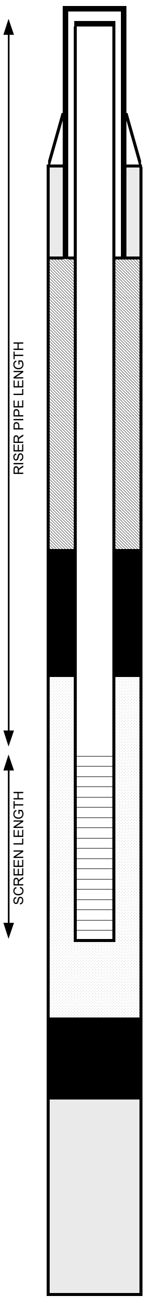
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant	WELL ID:	MW-16-07
PROJ. NO: 231828.0003	DATE INSTALLED: 3/9/2016	INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
592.58	2.7 TOP OF CASING
589.89	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
	GROUT/BACKFILL METHOD: TREMIE
135.7	
	125.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	130.0 BENTONITE SEAL
456.9	133.0 TOP OF SCREEN
5.00	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
451.9	138.0 BOTTOM OF SCREEN
	140.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: WASHED SAND
449.89	140.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 140 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 120 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	138.02	T/PVC	3/9/2016	--
DTB AFTER DEVELOPING:	141.19	T/PVC	4/13/2016	11:56
SWL BEFORE DEVELOPING:	14.66	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	14.25	T/PVC	3/18/2016	--
OTHER SWL:	16.83	T/PVC	4/13/2016	11:56
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

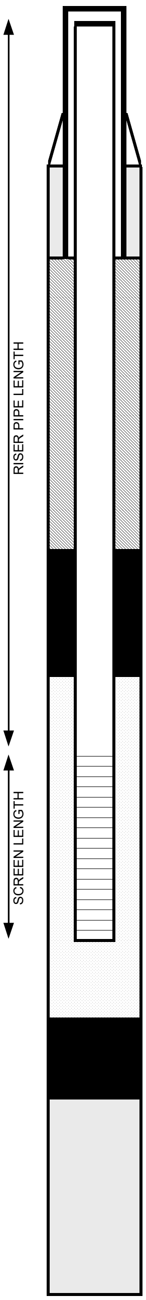
LOCK KEY NUMBER: 3120

TRC

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant		WELL ID:	**MW-16-08**
PROJ. NO:	231828.0003	DATE INSTALLED: 3/10/2016	INSTALLED BY: A. Knutson	CHECKED BY: C. Scieszka

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
591.88	2.6 TOP OF CASING
589.31	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
	GROUT/BACKFILL METHOD: TREMIE
135.6 (RISER PIPE LENGTH)	
	125.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	130.0 BENTONITE SEAL
456.3	133.0 TOP OF SCREEN
5.00 (SCREEN LENGTH)	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
451.3	138.0 BOTTOM OF SCREEN
	140.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: WASHED SAND
449.3	140.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 140 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 125 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN /GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	137.94	T/PVC	3/11/2016	--
DTB AFTER DEVELOPING:	140.80	T/PVC	4/13/2016	12:00
SWL BEFORE DEVELOPING:	14.23	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	14.23	T/PVC	3/18/2016	7:30
OTHER SWL:	15.79	T/PVC	4/13/2016	12:00
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

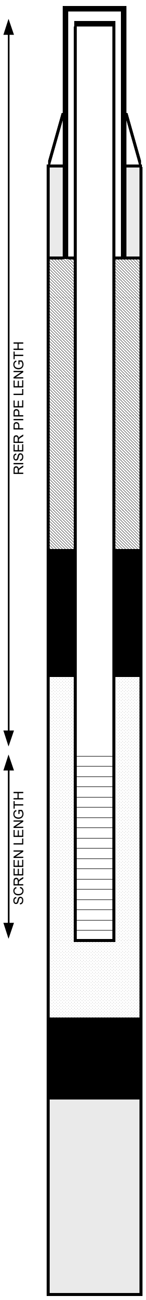
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant		WELL ID:	MW-16-09
PROJ. NO:	231828.0003	DATE INSTALLED: 6/2/2016	INSTALLED BY: J. Reed	CHECKED BY: M. Powers

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
590.80	2.5 TOP OF CASING
588.28	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
138.4	GROUT/BACKFILL METHOD: TREMIE
	130.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	133.0 BENTONITE SEAL
452.4	136.0 TOP OF SCREEN
5.00	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
447.4	141.0 BOTTOM OF SCREEN
	141.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NATURAL COLLAPSE
438.4	150.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 150 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 7 HOURS

WATER REMOVED: 30 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: TURBID

COLOR BEFORE: GRAY

CLARITY AFTER: VERY TURBID

COLOR AFTER: GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	140.00	T/PVC	6/7/2016	12:00
DTB AFTER DEVELOPING:	140.00	T/PVC	6/8/2016	10:25
SWL BEFORE DEVELOPING:	7.00	T/PVC	6/7/2016	12:00
SWL AFTER DEVELOPING:	117.42	T/PVC	6/8/2016	10:25
OTHER SWL:	16.76	T/PVC	6/9/2016	15:13
OTHER DTB:	144.30	T/PVC	6/9/2016	15:13

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

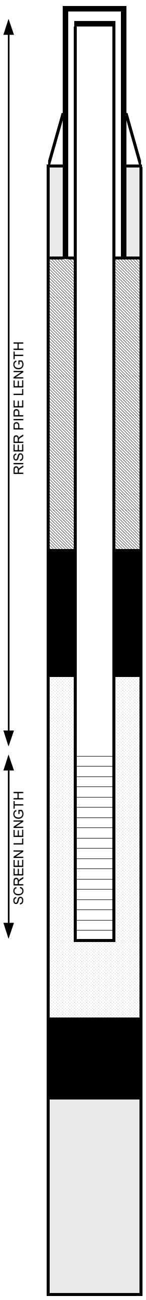
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant	WELL ID:	MW-16-10
PROJ. NO: 231828.0003	DATE INSTALLED: 6/6/2016 INSTALLED BY: J. Reed		CHECKED BY: M. Powers

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
592.26	3.0 TOP OF CASING
589.25	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
	GROUT/BACKFILL METHOD: TREMIE
148.0	
	137.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	142.0 BENTONITE SEAL
444.3	145.0 TOP OF SCREEN
	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
5.00	
439.3	150.0 BOTTOM OF SCREEN
	150.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NA
439.3	150.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 150 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4.5 HOURS

WATER REMOVED: 85 GALLONS

WATER ADDED: 60 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: DARK GRAY

CLARITY AFTER: VERY TURBID

COLOR AFTER: DARK GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	151.30	T/PVC	6/9/2016	7:45
DTB AFTER DEVELOPING:	152.28	T/PVC	6/9/2016	16:50
SWL BEFORE DEVELOPING:	17.80	T/PVC	6/9/2016	7:45
SWL AFTER DEVELOPING:	59.44	T/PVC	6/9/2016	16:50
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

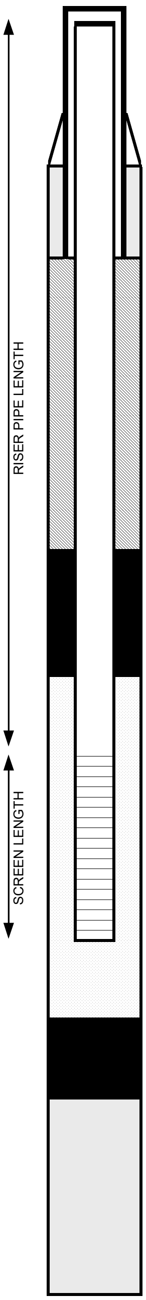
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant	WELL ID:	**MW-16-11**
PROJ. NO: 231828.0003	DATE INSTALLED: 6/7/2016	INSTALLED BY: J. Reed	CHECKED BY: M. Powers

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
591.54	2.5 TOP OF CASING
589.03	0.0 GROUND SURFACE
	1.0 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
139.5	GROUT/BACKFILL METHOD: TREMIE
	130.0 GROUT
	BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	135.0 BENTONITE SEAL
452.0	137.0 TOP OF SCREEN
5.00	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
447.0	142.0 BOTTOM OF SCREEN
	150.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: WASHED SAND
447.0	150.0 HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 150 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 3 HOURS

WATER REMOVED: 84 GALLONS

WATER ADDED: 60 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: DARK GRAY

CLARITY AFTER: VERY TURBID

COLOR AFTER: GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	141.36	T/PVC	6/9/2016	12:35
DTB AFTER DEVELOPING:	142.00	T/PVC	6/9/2016	15:45
SWL BEFORE DEVELOPING:	9.65	T/PVC	6/9/2016	12:35
SWL AFTER DEVELOPING:	116.00	T/PVC	6/9/2016	15:45
OTHER SWL:	16.67	T/PVC	6/21/2016	7:45
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

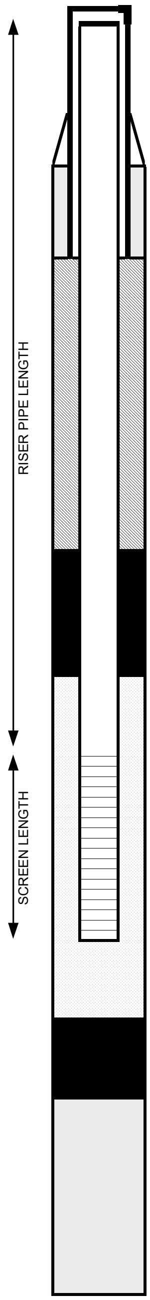
PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant	WELL ID:	**MW-16-11A**
PROJ. NO:	265996.0003	DATE INSTALLED: 5/12/2017 INSTALLED BY: Jake Krenz	CHECKED BY: C. Scieszka



ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)
591.66	2.1 TOP OF CASING
589.52	0.0 GROUND SURFACE
	1.5 CEMENT SURFACE PLUG
	GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
139.1	GROUT/BACKFILL METHOD: TREMIE
	131.5 GROUT
	BENTONITE SEAL MATERIAL: PELLETS
	134.0 BENTONITE SEAL
452.5	137.0 TOP OF SCREEN
5'	FILTER PACK MATERIAL: MEDIUM, WASHED SAND
447.5	142.0 BOTTOM OF SCREEN
	142.0 BOTTOM OF FILTER PACK
	NA BENTONITE PLUG
	BACKFILL MATERIAL: NA
447.52	142.0 HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SOLVENT USED? NO

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 142 FT.; NA IN. FROM NA TO NA FT.

SURF. CASING DIAMETER: NA IN. FROM NA TO NA FT.; NA IN. FROM NA TO NA FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 3 HOURS

WATER REMOVED: 110 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: Very Turbid

COLOR BEFORE: Dark Gray

CLARITY AFTER: Very Turbid

COLOR AFTER: Light Gray

ODOR (IF PRESENT): None

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	141.98	T/PVC	5/15/2017	0838
DTB AFTER DEVELOPING:	145.45	T/PVC	5/15/2017	1612
SWE BEFORE DEVELOPING:	17.79	T/PVC	5/15/2017	0838
SWE AFTER DEVELOPING:	90.12	T/PVC	5/15/2017	1612
OTHER SWE:		T/PVC		
OTHER SWE:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

Appendix D
Subsurface Investigation and Foundation Report, Bechtel, 1976.

4-G-5-1

SUBSURFACE INVESTIGATION AND FOUNDATION REPORT

THE DETROIT EDISON COMPANY

BELLE RIVER UNITS 1 & 2

JOB 10539

VOLUME 1 OF 2

GEOLOGY AND SOIL PROPERTIES

AUGUST 1976

BECHTEL
ANN ARBOR, MICHIG

BECHTEL

SUBSURFACE INVESTIGATION

AND

FOUNDATION REPORT

GEOLOGY AND SOIL PROPERTIES

BELLE RIVER PLANT

UNITS 1 & 2

JOB 10539

THE DETROIT EDISON COMPANY

S. S. Afifi

D. R. Gle

GEOTECHNICAL SERVICES

ANN ARBOR, MI

SUBSURFACE INVESTIGATION
AND
FOUNDATION REPORT
GEOLOGY AND SOIL PROPERTIES

BELLE RIVER PLANT
UNITS 1 & 2
JOB 10539
THE DETROIT EDISON COMPANY

S. S. Afifi
D. R. Gle
GEOTECHNICAL SERVICES
ANN ARBOR, MI

Volume 1 of 2

TABLE OF CONTENTS

APPENDICES

Volume 2 of 2

ABSTRACT

This report presents the results of an extensive subsurface investigation program for the Detroit Edison Company at the Belle River Project site. The proposed project consists of a two-unit coal fired plant and the associated coal handling facilities. The study was directed at evaluation of the geologic and ground water conditions and the development of soil parameters for design and construction of the proposed facilities.

The evaluations presented in this report consist of a review of previous investigations, a literature review, and detailed subsurface investigation and laboratory testing programs. This investigation confirmed the suitability of the site for the proposed facilities and gave the soil mechanics information necessary for planning, design and construction of plant facilities.

PREFACE

This report was prepared by Geotechnical Services in the Ann Arbor Office of Bechtel. The soils sections of this report were prepared by D.R. Gle and the geology sections by J.V. Mrakovich. J.B. Givens also contributed to the soil data evaluations. The Ann Arbor Office review and approval was by S. Mackay and G.T. LeFevre, Engineering Geology Supervisors, and S.S. Afifi, Soils Engineering Supervisor. The San Francisco H & CF review and approval was by M.J. Adair, Chief Geologist, and W.R. Ferris, Chief Soils Engineer. The report was also reviewed by S.L. Blue, Geotechnical Services Manager, H & CF Division, Ann Arbor, Michigan. The report was collated by A.R. Rossmann, Drafting Supervisor, Ann Arbor.

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

NOTATION

$\underline{A}$	Pore pressure parameter (Skempton)
C_c	Compression index
C_r	Swelling index
C_v	Coefficient of consolidation
c	Cohesion intercept for total stresses from Mohr-Coulomb Relationship
c'	Cohesion intercept for effective stresses from Mohr-Coulomb Relationship
$\overline{CU}$	Consolidated-undrained triaxial compression test with pore pressure measurement
D_{50}	Grain size analysis: diameter at which 50% of the sample is finer
E	Young's modulus of elasticity as determined from the initial tangent modulus of the stress-strain curve
e_o	Initial void ratio
k	Permeability
ksf	Kips per square foot
LL	Liquid limit
PI	Plasticity index (LL-PL)
P_c	Preconsolidation pressure
PL	Plastic limit
$\bar{P}$	Effective vertical pressure
P_o	In-situ effective overburden pressure
p	Stress point, $(\sigma_1 + \sigma_3)/2$
p'	Stress point, $(\bar{\sigma}_1 + \bar{\sigma}_3)/2$

pcf	Pounds per cubic foot
psf	Pounds per square foot
q	Stress point, $(\sigma_1 - \sigma_3)/2$
Qu	Unconfined compression test
s	Shear strength
SPT	Standard penetration test (ASTM D 1586)
s_u	Undrained shear strength
UU	Unconsolidated-undrained triaxial compression test
w_o	Initial moisture content
w_f	Moisture content after consolidation ($\overline{CU}$ test)
γ_d	Dry density
γ_t	Total density
γ_{tf}	Total density after consolidation ($\overline{CU}$ test)
ϵ	Axial strain
σ	Total normal stress on failure plane at failure
σ'	Effective normal stress on failure plane at failure
σ_o	Confining pressure (unconsolidated-undrained triaxial test)
$\bar{\sigma}_3$	Effective confining pressure (consolidated-undrained triaxial test)
ϕ	Angle of internal friction for total stresses
ϕ'	Angle of internal friction for effective stresses
τ	Drained shear strength

1.0 INTRODUCTION

The Detroit Edison Company's proposed Belle River Project consists of a two-unit coal fired power plant and the associated coal handling facilities. The project site is located in St. Clair County, Michigan, between the cities of St. Clair and Marine City. Figure 1 shows the state of Michigan with the site location indicated. This site is just west of the existing Detroit Edison Company St. Clair Power Plant. A general site plan showing all of the existing and proposed facilities is shown in Figure 2.

The coal handling facilities will include a docking facility, transfer houses, radial stackers, underground coal reclaimers and a conveyor system, along with both primary and secondary coal storage areas. The proposed power block will consist of two boiler buildings, two turbine buildings, four precipitators, a smoke stack, service building, administration building, warehouse, and miscellaneous other tanks and treatment basins. Other facilities away from the power block include a switchyard and intake and discharge structures.

The project facilities are superimposed on the boring location plan and are shown in Figure 3. The area proposed for fly ash disposal (Figure 4) has also been considered in the evaluations.

Volume 1 of this report contains the final results of the geological evaluations, laboratory soil testing, soil properties evaluations, and the development of the soil engineering parameters to be used for the entire Belle River 1 & 2 Project area. The results of previous investigations supplied by The Detroit Edison Company are given in Appendix A. Bechtel soil/rock borings are presented in Appendix B, along with a tabulated summary and a key to the notation used on the boring logs.

Volume 2 contains Appendices C and D which include all of the laboratory test results. Appendix C contains the results of laboratory tests performed by Goldberg-Zoino and Associates while Appendix D contains the results of laboratory tests conducted by U. W. Stoll and Associates.

The engineering design criteria for the various portions of this project will not be addressed in this report. Design criteria will be addressed upon reactivation of the project when more details are known about the proposed facilities and the final location of structures.

2.0 SCOPE OF WORK

The purpose of the subsurface investigation and laboratory testing program was to evaluate the soil, rock, and ground water conditions at the site in order to provide sufficient information for planning, design, and construction of the various plant facilities. Upon reactivation of this project, foundation systems and parameters for the various foundation design, construction, and soil structure interaction schemes will be developed based on this information.

This report is based on a review of previous investigations, geologic research, ground water studies, soil and rock drilling and sampling, and a laboratory testing program.

3.0 SUBSURFACE EXPLORATION

3.1 PREVIOUS EXPLORATION FOR THE EXISTING ST. CLAIR PLANT

Borings were made for various structures and facilities of the St. Clair power plant during 1950, 1959, and 1965. These are contained in a report prepared under the direction of W. S. Housel and the University of Michigan's Office of Research Administration, Soil Mechanics Laboratory for the addition to St. Clair Unit No. 7. The 1950 borings were generally in the area of the main plant while the 1959 and 1965 borings were made for the dock area and yard conveyor, respectively.

Included in the Housel report are the individual boring log profiles of borings made during 1965 and composite subsoil analysis profiles extending to bedrock. It also contains information on comparisons with borings made in the same area during 1950 and 1959. Through 1965, a total of 28 borings were drilled east of M-29 along the shore of the St. Clair River and within the St. Clair plant area. Seven borings were drilled west of M-29 along the yard conveyor. The Housel report and other borings in the area made available to Bechtel are included in Appendix A of this volume.

3.2 EXPLORATION FOR THE PROPOSED BELLE RIVER PROJECT

3.2.1 General

The existing docking facility was rebuilt to accommodate larger ships approximately 105 feet wide and 1000 feet long having a draft of about 27.5 feet. The existing conveyor system serving the present St. Clair units will remain in place. A new conveyor system will begin at the docking facility and parallel the existing system to Highway M-29, where it will bridge across M-29 and bisect the new primary coal storage area.

From the primary coal storage area, the conveyor system crosses over the Detroit and Port Huron Railroad tracks and turns northward towards the main plant area and the secondary coal storage pile. The conveyor will then split, with one conveyor going west into the main plant and the other going east, over the railroad tracks, to the secondary coal storage area. Also located along the conveyor system are various transfer houses and stacker-reclaimers as shown in Figures 2, 3 and 4.

The primary coal storage area is separated into three storage locations covering an area of approximately 75 acres. There are two main dead storage piles to the north and south sides of the conveyor, and a smaller live storage pile between the conveyor and the south dead coal storage. An approximate capacity of 2.5 million tons of coal can be stored at these locations.

The secondary coal storage area will consist of a single coal pile located just east of the main plant. This pile will cover an area of approximately 20 acres, and will have a total dead storage capacity of approximately one million tons.

In addition, there will be a large fly ash disposal area to the northwest of the main plant. In general, this area is bounded by the existing Remer Road, King Road, the Detroit and Port Huron Railroad, and a line about one-half mile north of and parallel to Puttygut Road.

3.2.2 Details of Exploration

The subsurface exploration program and foundation evaluation were developed by Bechtel. The drilling, which was done by Raymond International, began in November 1973 and ended in August 1975. Bechtel soil engineer(s) and Bechtel engineering geologist(s) supervised field operations and recorded field logs of the drilling, sampling, and field testing of the foundation materials. Logs of all borings were prepared by Bechtel and are included in Appendix B.

In the docking area, ten 5-inch diameter exploratory borings were drilled and sampled to bedrock. In addition, 74 other rotary wash borings were drilled along the conveyor system, the coal storage areas, and the main plant area. A total of 36 borings were drilled in the fly ash disposal area northwest of the main plant. These borings were located on approximately a 1,000 foot grid and extended to depths of from 70 to 140 feet. Undisturbed samples were obtained in selected borings while split spoon samples were obtained in all of the remaining borings to verify the subsurface materials and consistency.

Throughout this investigation, undisturbed samples were generally taken at 10-foot intervals with standard 3-inch O. D. Shelby tubes. From a depth of approximately 15 to 70 feet, some difficulty was encountered in retaining the very soft clayey soils in the standard Shelby tube, and the Osterberg Sampler was used to recover samples within this depth. Generally, this sampler enabled adequate recovery.

Material in each undisturbed sample was visually classified by the Bechtel field engineer. The tubes were then sealed with a double layer of wax, labeled, and selected tubes were shipped to the laboratory.

Drive samples were obtained at the alternate 10-foot intervals between undisturbed samples using a standard split spoon sampler. This procedure (ASTM D 1586) utilizes a 140-pound hammer falling 30 inches to drive a 1-3/8 inch I.D. split spoon sampler 18 inches. Blows required to advance the sampler through each six inches were recorded. The standard penetration test (SPT) blowcount is the number of blows for the last foot the sampler is driven. Standard penetration test blowcounts are given on the boring logs. In the exceptionally hard materials found at depths of approximately 130 to 135 feet, refusal was considered to have been attained when 100 blows were delivered for any six inch driving increment.

Material recovered in the split spoon sampler was visually classified by the engineer, and a portion of the sample was then stored in a glass jar. Selected jar samples were sent to the testing laboratory for classification.

Classifications made in the field were compared with the laboratory classification during proofreading of each field log and the appropriate corrections were then made on the final boring log. The unified soil classification for each sample is as shown on the boring logs given in Appendix B.

Rock cores were obtained in areas where the foundation system has a possibility of bearing on bedrock. Specified holes were cored a minimum of 20 feet into rock to assure positive penetration through the overburden and to obtain samples to evaluate the competency of the rock.

Cores were placed in partitioned core boxes (each holding about 15 feet of core), classified, and stored at the site. Bechtel geologists prepared lcgs of the rock core portions of each hole.

At the completion of the investigation, the remaining sample jars, Shelby tube samples, and rock core samples were stored at the St. Clair Power Plant.

4.0 SITE CONDITIONS

This section addresses the geology and generalized subsurface soil conditions for this site. The geological studies were based on a literature review, evaluation of site boring logs, and ground water measurements. The soil conditions were developed from an evaluation of the boring logs and laboratory soil tests, along with geologic and ground water evidence and also a review of previous investigations.

4.1 GEOLOGY

4.1.1 Regional Geology

The site is located in the Lower Peninsula of Michigan on the southeastern margin of the Michigan Basin (Figure 5). This basin is a broad, shallow, tectonic structure approximately 300 miles in diameter and containing up to 14,000 feet of Paleozoic sediments in its central portion near Mount Pleasant. Thickening of strata toward the center of the basin indicates that the Lower Peninsula was a region of slow subsidence with almost continuous deposition throughout the Paleozoic. A large part of basin development occurred during Silurian, Middle and Upper Devonian time when about two-thirds of the total Paleozoic sequence was deposited. Subsidence apparently ceased at the close of Jurassic time, about 135 million years ago, since no rocks of younger age are known to exist in the region.

During the Pleistocene, continental glaciers advanced and retreated across the region many times, modifying the bedrock topography and covering it with glacial drift, which now comprises almost all natural topographic features at the site and in the Lower Peninsula.

Faulting is not common to the region, and no known faults occur near the site. The nearest mapped faulting occurs in the area of the Chatham Sag in eastern Ontario, about 15 miles southeast of the site; however, it is considered inactive (Ref 1).

The Lower Peninsula of Michigan is an area of low seismic activity where only six earthquakes have been recorded in historic time. None of these earthquakes can be related to mapped faults or tectonic structures in the Michigan Basin. According to the seismic risk map of the U.S. (Ref 2), the site is located in Zone 1 which corresponds to Intensities V and VI (Modified Mercalli Scale of 1931), where only minor damage should be expected.

4.1.2 <u>Site Geology</u>

The site is located in St. Clair County, Michigan, 3.5 miles south of the city of St. Clair on an intermorainal glacial lake plain (Figure 6) whose ground surface varies little above or below 587 feet in elevation.

These glacial lake deposits vary in thickness from 125 to 170 feet within the explored area of the site where they overlie an irregular bedrock surface (Figure 7). The underlying bedrock consists of about 4,600 feet of Paleozoic sedimentary rocks whose uppermost unit is the Bedford Shale formation of Mississippian-Devonian Age. The Paleozoic rocks are underlain by metamorphic, igneous, and sedimentary rock of Precambrian Age (Ref 3).

Overburden materials consist primarily of unconsolidated gray to brown, soft to stiff silt and silty clays with scattered fine sand lenses. Figure 8 shows overburden thickness contours throughout the site area and the cross sections of Figure 9, A through N, show local detailed descriptions of site material.

The most prominent feature of the bedrock topography is a generally north-south trending erosional channel in the vicinity of the proposed plant. Subsurface profiles (Figure 9, A through N), normal to and along the trend of the channel, show an associated sand deposit whose known maximum thickness is about 60 feet. Generally, the sand appears to be in contact with the bedrock surface and thins rapidly, or becomes absent, away from the channel. As evidenced by the drill hole logs, the sand occurs sporadically elsewhere across the site. Sand thickness and top of sand contour maps (Figures 10 and 11, respectively), as well as the cross sections in Figure 9, A through N, show that the location of these sand deposits is controlled mainly by the bedrock surface. The deposits generally fill low areas on this bedrock surface, suggesting the basal sand is glaciofluvial outwash in origin and represents some of the first material deposited on bedrock by meltwaters from nearby glaciers.

Except for the basal glaciofluvial sand, all other glacial material underlying the site appears to be glaciolacustrine silty clays and silts with local sand lenses.

Bedrock at the site is the Bedford Shale formation of Mississippian-Devonian Age. The rock, cored to a maximum depth of 50 feet, consists of light to dark gray shale varying from soft to firm. The soft shale in the upper bedrock sequence is generally weathered and highly fractured. The firm shale below is occasionally fractured, but local vein quartz infilling has strengthened the rock by acting as a cementing agent. The estimated top of firm rock (base of the weathered portion) is shown on the subsurface profiles (Figure 9, A through N).

Rock stratigraphy below a depth of 50 feet to the top of the Niagara group was interpreted from logs of five abandoned wildcat oil and gas wells located on the site (Figure 12). The remainder of the Paleozoic interval was interpolated from nearby stratigraphic cross sections (Ref 4) and the Michigan Geological Survey Annual Statistical Summary No. 18, Michigan's Oil and Gas Fields, 1972 (Ref 5). This rock stratigraphy is summarized in the geologic column in Figure 13.

4.1.3 Ground Water

The site is underlain by relatively impermeable glaciolacustrine, silty clays and silts ranging in thickness from 125 to 170 feet with local lenses of glaciofluvial sands. These sand lenses are moderately permeable but are too small to store or transmit much water. Beneath portions of the site, a basal, glaciofluvial, compact sand and silty sand is encountered immediately above the bedrock surface. These sands attain a known maximum thickness of about 60 feet in the vicinity of the proposed plant structures. Water losses, occurring in these basal sands during the site exploration drilling program, indicate they are relatively permeable. Locally, throughout the region surrounding the site, these sands yield enough ground water for domestic and farm use (Ref 6).

A zone of highly fractured shale, between the top of rock and the top of firm rock is moderately permeable. The highly fractured shale ranges in thickness from zero feet to over 45 feet in rock cores, and is indicated on subsurface profiles in Figure 9, A through N. The permeable shale zone and the basal glaciofluvial sands probably act as a single aquifer where they are in direct contact with each other.

Yields from most wells in the area, placed either in glacial deposits or in bedrock, are less than ten gallons per minute. Ground water development is primarily for domestic and farm use. Municipal and industrial water is principally obtained from surface water bodies.

Ground water levels at the site were measured from four observation wells installed during the site exploration program. Hydrographs displaying water level elevations in the four observation wells, with respect to time, are shown in Figure 14. The initial slopes of the hydrographs indicate the time required for water levels in the observation wells to reach a hydrostatic level.

The water level of Observation Well 181, set at Elevation 449.8 near the highly fractured shale bedrock, stabilized 24 hours after installation; whereas, water levels of Observation Wells 7 and 24, set in glaciolacustrine silts at Elevations 450.5 and 452.3 respectively, required several months to stabilize, indicating they are essentially impermeable. The water level of Observation Well 40, placed in a glaciolacustrine silty clay with some sand and gravel, at Elevation 509.1, stabilized in three weeks, also indicating very low permeability.

Ground water contours of the probable water surface beneath the site are shown in Figure 15. Water level data spanning several years, obtained from the Michigan State Geological Survey, was used in constructing the ground water contours.

This data was used in conjunction with water level readings obtained in June 1974 from observation wells on the site.

Elevation of the ground water varies by about ten feet in the site area, generally increasing toward the St. Clair River. Water movement beneath the site appears to be westward away from the St. Clair River which is probably a recharge area. Approximate ground water levels are also shown on the subsurface profiles (Figure 9, A through N).

Depth to ground water on the site varies from 5 to 15 feet. Seepage of ground water into pits excavated below the zone of water saturation will probably be slow due to the very low permeability of the silty clays and silts that underlie the site. Pits excavated to a depth of 30 to 40 feet for the purpose of fly ash disposal were observed to contain no water from ground water seepage when left open for several days. The low permeability of the glaciolacustrine deposits is also indicated by the slow response of water levels in observation wells placed in either silty clays or silts. In cases where local sand or gravel lenses are encountered during excavations, ground water seepage may be substantial. However, a sump pumping system should be sufficient to control ground water seepage from sand and gravel lenses, since these are generally small in size and cannot store much water. When predrilling for piles, water losses may be experienced when drilling through the basal glaciofluvial sand layer.

According to a southeastern Michigan water resources study (Ref 6), ground water from the glacial deposits is of the sodium bicarbonate type. In general, sodium and chloride concentration increase with depth. Water hardness ranges in concentration from 68.4 to 342.0 parts per million calcium carbonate, and iron ranges in concentration from 0.5 to 1.0 parts per million. Water from wells in bedrock varies in chemical composition, usually containing large amounts of calcium, bicarbonate, sulfate, and sodium chloride.

Knutilla's report (Ref 6) also indicates small to moderate supplies of fresh water are available from the highly fractured shale zone, but nearly all water is too highly mineralized for most uses. In general, mineralization of water increases with depth, whether in glacial deposits or bedrock.

4.1.4 Effects of Man's Activities

4.1.4.1 Presence of Oil and Gas

There are no active producing oil or gas fields in the immediate site area. Ten exploratory wells have been drilled on the site to an average depth of 2,500 feet. All wells were nonproductive except for two oil and gas producing wells located in the northwest corner of the site. These wells, producing from Niagaran reef formations, were abandoned in 1970.

Several oil and gas fields associated with reef structures have been developed in St. Clair County. The size of these fields averages 570 acres and oil production rates in 1971 were about 25 gallons per acre per day. All oil and gas fields surrounding the site appear to be fully developed and no further expansion is expected. Present oil and gas extraction are not expected to present problems to the plant structures. Figure 12 shows the locations of oil and gas wells on the site and in the site vicinity.

Isolated pockets of trapped gas occur in the overburden underlying the site. Gas was encountered in seven exploration borings (Table 1). No odor was detected in any of these borings, and in all cases, the gas dissipated after 48 hours. Safety measures for determining the existence of and handling the gas should, however, be included in all earthwork and foundation contracts. No unusual design or construction problems due to the presence of gas are expected.

4.1.4.2 Salt Solution Mining

Thick salt deposits occur in two geologic horizons in Michigan: the Devonian Detroit River group and the Silurian Salina group. Salt beds in the Detroit River group are restricted to the northern half of the Lower Peninsula and do not underlie the site area. However, salt beds in the Salina group have a large areal extent covering the central three-fourths of the Lower Peninsula and occur beneath the site.

Salt solution mining from the Salina group by the Diamond Crystal Salt Company, located approximately one mile north of the site boundary, has been in progress for a number of years. The Salina group underlying the site contains five salt units interbedded with dolomitic shale, limestone, and anhydrite. The aggregate thickness of the salt is about 750 feet with the uppermost and lowermost units occurring, respectively, at depths of approximately 1,400 and 2,500 feet below the site.

The potential for surface subsidence due to the collapse of solution cavities was evaluated from criteria used by the U.S. Bureau of Mines (Ref 7). A potential area of subsidence can be obtained by drawing a cone with sides at a 45° angle upward from the cavity. Surface subsidence due to that cavity will be within the area encircled by the cone's intersection with the ground surface.

A cavity at a depth of 2,500 feet will have a potential area of surface subsidence extending outward 2,500 feet from the cavity's edge. At the present location of the Diamond Crystal Salt Company's operations, surface subsidence due to a salt cavity at a depth of 2,500 feet is not expected within the site. It should be emphasized that further solution mining should not be permitted to develop cavities closer than 2,500 feet (horizontally) from any plant structures.

4.2 SUBSURFACE SOIL CONDITIONS

4.2.1. <u>General</u>

The soil profile at this site may be divided into three major strata. These divisions were based upon field observations combined with results of all laboratory testing. These strata have been designated as the upper, middle, and lower strata and refer to depths of 0 to 20 feet, 20 to 50 feet, and below 50 feet, respectively. Except for the dock, secondary coal storage area, and fly ash disposal areas, the entire site has a surface elevation of about Elevation 586, generally ranging from Elevation 585 to Elevation 590. The dock area is lower at Elevation 580 to Elevation 582, while the secondary coal storage area and fly ash disposal area are higher at approximately Elevation 590 and 600 respectively. Therefore, the depths of the different strata are approximate and are expected to vary within 5 to 15 feet throughout the entire project site. For any particular location, the boring logs should be consulted to associate the soil properties with a particular stratum. Generalized ground surface contours are shown in Figure 16.

Selected subsurface profiles throughout the entire site are shown in Figure 9, A through N. The distribution of standard penetration blowcount with depth for various areas is shown in Figure 17.

4.2.2 Upper Stratum (0-20 Feet)

The upper stratum consists primarily of mottled brown and gray, stiff to very stiff, clays (Classification CL-CH) with traces of fine sand and pebbles. Standard penetration blowcounts increased from approximately 5 to 15 at the ground surface to a range of from 10 to 40 at a depth of 10 feet (Figure 17). Below this depth, the blowcounts decreased to a range of from 3 to 12 at a depth of approximately 20 feet. Below 20 feet, there is an observable change in the color and consistency of the clay; therefore, a depth of 20 feet is considered the bottom of the upper stratum at this site.

Laboratory consolidation testing has shown this stratum to be overconsolidated. This preconsolidation was also confirmed by the results of consolidated-undrained triaxial testing, the empirical Skempton relationship as used to determine preconsolidation pressure based on the undrained shear strength of the soil and the liquid limit (Ref 8), and also a comparison of the natural moisture content with the

Atterberg limits. It is believed that this stratum was preconsolidated by desiccation based on undrained shear strength behavior and other geologic evidence. The estimated preconsolidation pressure ranges between 4,000 to 9,000 psf. This corresponds to an overconsolidation ratio between 4 and 8.

4.2.3 Middle Stratum (20 to 50 Feet)

Below the upper stratum, there is a very soft to soft gray silty clay (Classification CL) which extends from approximately 20 feet below the ground surface to 50 feet below the ground surface. However, this stratum was encountered as close as 11 feet from the ground surface in the dock area.

Standard penetration blowcounts in this stratum ranged between fairly close limits. In all areas except the docking facility, blowcounts ranged from 2 to 7 blows per foot. Generally, the higher blowcounts were noted at the top and bottom of the stratum and decreased in the center. At the docking facility, the average blowcounts remained constant at about 2 blows per foot throughout the entire depth, and the higher blowcounts remained constant at an average of 15 blows per foot. Although blowcounts at the docking facility were somewhat lower than other locations, laboratory engineering properties were not significantly different.

Consolidation tests and other empirical evaluations show this stratum to be slightly overconsolidated, with preconsolidation pressures ranging between 3,500 to 4,500 psf. This corresponds to an overconsolidation ratio between 1.3 and 2.0.

4.2.4 Lower Stratum (Below 50 Feet)

This stratum consists primarily of a firm gray plastic silty clay Classification (CL). However, some fine sand seams and silty clays with an appreciable amount of sand (as much as 40%) were encountered at varicus depths as shown in the subsurface profiles (Figure 9, A through N). Significant sand deposits were also found beneath the main plant area as noted in Section 4.1.2.

Blowcounts in this stratum varied depending on the amount of sand present. Typical standard penetration blowcounts ranged from 2 to 7 blows per foot at a depth of 50 feet, to 10 to 25 blows per foot at a depth of 70 feet. Below the 70 foot depth, the standard penetration blowcount in the clay soils increased to an average of approximately 20 blows per foot at a depth of 125 feet (range of 5 to 40). Below this depth, the blowcounts in all areas increased until bedrock was encountered at depths of 125 to 145 feet. Within this depth range, clays with high sand content, sand deposits, hardpan, or combinations were encountered above the bedrock. Standard penetration blowcounts in the sandy zones above the bedrock are quite variable, although the average was found to be 40 to 50 blows per foot.

Except where a significant amount of sand was present, this stratum can be subdivided into three layers based on the degree of overconsolidation. These layers are from 50 to 70 feet (transition zone between upper and middle strata), 70 to 90 feet and below 90 feet, respectively.

4.2.4.1 Layer From 50 to 70 Feet (Transition Zone)

The first of these layers is designated as the transition zone and ranges from 50 to 70 feet deep. According to Skempton's statistical relationship and the natural moisture content and plasticity ranges, the soils within this layer are slightly overconsolidated. The Skempton empirical procedure was used to evaluate the preconsolidation pressure because of the lack of a sufficient number of consolidation tests for this layer. The estimated preconsolidation pressure for this layer ranges between 4,000 to 8,000 psf. This corresponds to an overconsolidation ratio between 1.0 and 1.6.

4.2.4.2 Layer From 70 to 90 Feet

Based on consolidation tests and the same Skempton relationship, the soils within the depth range of 70 to 90 feet are considered slightly overconsolidated but to a greater degree than the transition zone. Apparently, the normal geological process of deposition of the clay was interrupted at this depth. Since the soil appears to be virtually the same type as that below it, this increased overconsolidation must be due to either additional deposition above 70 feet and then erosion to the 70-foot depth, or desiccation as was noted in the upper layer, followed by deposition to its present elevation. The undrained shear strengths have the general tendency to decrease very slightly with depth below 70 feet, thus the apparent overconsolidation is likely due to desiccation. The estimated preconsolidation pressure for this layer ranges between 6,000 and 9,000 psf. This corresponds to an overconsolidation ratio between 1.0 and 2.4.

4.2.4.3 Layer Below 90 Feet

The soil properties below 90 feet are very similar to those immediately above, except for the degree of overconsolidation and undrained shear strength. Consolidation test results and evaluation of the moisture content versus Atterberg limits show these soils to be very slightly overconsolidated to normally consolidated. The estimated preconsolidation pressure for this strata ranges between 6,000 and 9,000 psf. This ccrresponds to an overconsolidation ratio between 1.0 and 1.2.

5.0 LABORATORY SOIL TESTING

5.1 INTRODUCTION

The laboratory testing program consisted of the classification and engineering properties tests listed below and further described in this Section. The testing program was developed by Bechtel and conducted by Goldberg-Zoino and Associates and U. W. Stoll and Associates under the direction of Bechtel.

a) Visual and Laboratory Classification

b) Moisture Content and Dry Unit Weight

c) Atterberg Limits

d) Specific Gravity

e) Mechanical Analysis

f) Unconfined Compression Test (Qu)

g) Laboratory Vane Shear Test

h) Unconsolidated-Undrained Triaxial Compression Test (UU)

i) Consolidated-Undrained Triaxial Compression Test With Pore Pressure Measurement ($\overline{CU}$)

j) Consolidation Test

k) Permeability Test

l) Compaction Test

The majority of testing was carried out by Goldberg-Zoino and Associates of Newton Upper Falls, Massachusetts, from January 1974 through January 1975. Additional tests were made by U. W. Stoll & Associates of Ann Arbor, Michigan, during the summer of 1975. This was to provide more detailed information for the coal reclaim hopper south of Transfer House 5 (Figure 2).

The test data are presented in Appendix C of Volume 2 in the form of tables and figures. Selected properties such as dry density, moisture content, Atterberg limits, and soil cohesion from unconfined compression, unconsolidated-undrained triaxial testing and vane shear tests have also been included on the boring logs presented in Appendix B. Interpretation of test data and development of soil properties for design are presented in Section 6.

5.2 CLASSIFICATION TESTS

Visual classification was in accordance with ASTM D 2488, and laboratory classification was in accordance with ASTM D 2487.

5.2.1 Moisture Content and Dry Unit Weight

Moisture content and dry unit weight were determined for all undisturbed soil samples selected for any type of testing, along with the moisture contents for other selected split spoon samples. Determination of moisture content was made in accordance with ASTM D 2216 and the unit weight was determined by direct measurement.

5.2.2 Atterberg Limits

Atterberg limits determinations were made in accordance with ASTM D 423 (liquid limit) and ASTM D 424 (plastic limit) on all samples selected for unconfined and triaxial shear testing, consolidation testing, and on other selected plastic soils.

5.2.3 Specific Gravity

Specific gravity tests were made on all samples subjected to consolidation testing, as well as on other selected samples, in accordance with ASTM D 854.

5.2.4 Mechanical Analysis

Mechanical and hydrometer analysis determinations were made in accordance with ASTM D 422 on selected samples.

5.3 ENGINEERING PROPERTIES TESTS

5.3.1 Unconfined Compression Tests

Unconfined compression tests were performed on representative samples of all strata to evaluate the in situ shear strength. The tests were also performed on remolded samples to evaluate the soil sensitivity and the available shear strength under remolded conditions. All tests were performed in accordance with ASTM D 2166. Stress versus strain curves have also been presented in Appendix C. These allowed an evaluation of the shear strength at different strain levels and also the initial tangent modulus. Dry density, moisture content, and Atterberg limits are also reported for each test. Results for undisturbed samples are summarized in Table 2 while the results for compacted samples are summarized in Table 3.

5.3.2 Laboratory Vane Shear Tests

Vane shear tests were performed on selected soil samples from the dock area to evaluate both the undisturbed and remolded shear strengths. This was done primarily to determine the degree of sensitivity of the soil and also to compare the results with those of other undrained shear strengths. This data is summarized in Table 4.

5.3.3 Unconsolidated-Undrained Triaxial Compression Tests (UU)

Unconsolidated-undrained triaxial compression tests were made on selected undistrubed samples to compare with the results obtained from the unconfined compression testing. This test is also considered appropriate for cohesive samples which contain appreciable amcunts of silt or sand size particles. Procedures utilized were in accordance with ASTM D 2850.

All unconsolidated-undrained triaxial tests were performed at confining pressures approximately equal to the effective overburden pressure at the sample depth. The stress-strain curves, moisture contents, and dry densities are also given on the laboratory test result sheets in Appendix C. The results are summarized in Table 5.

5.3.4 Consolidated-Undrained Triaxial Compression Tests with Pore Pressure Measurements ($\overline{CU}$)

Consolidated-undrained triaxial compression tests with pore pressure measurements were made on undisturbed samples from all strata and on selected remolded samples using the Harvard Minature Compaction Method. All samples were saturated by the back pressure method. A minimum of three separate samples at the same approximate depth were then consolidated to confining pressures approximately equal to 0.5, 1.0, and 2.0 times the effective overburden pressure, respectively, before testing. Confining pressures, moisture contents, dry densities, etc. are shown on the test data sheets. Effective and total strength envelopes were obtained for each series tested. Plots of pore water pressure, deviator stress, principal stress ratio, and Skempton's A parameter versus strain are given in Appendix C. All results are summarized in Table 6.

5.3.5 Consolidation Tests

Consolidation tests on selected soil samples were made by loading test specimens up to applied pressures as high as 24 ksf in accordance with ASTM D 2435. A modification of ASTM D 2435 to provide a rebound-recompression curve near the overburden pressure (Burmister Loop) was also used on selected samples (Ref 9). This modification consisted of loading the test specimens to the approximate in-situ overburden pressure, or slightly above, and then reducing the load to either 2 or 4 ksf. Samples were then reloaded to the maximum pressure and rebounded to zero load. The consolidation bowl was filled with water when the pressure reached the approximate effective confining pressure at the sample depth. Tests on compacted samples were also made. Results of the consolidation tests and a summary of the coefficient of consolidation by both the square root and logarithm of time fitting method are included in Appendix C. The results of undisturbed and compacted samples are summarized in Tables 7 and 8, respectively.

5.3.6 Permeability Tests

Laboratory permeability tests were performed on representative clay specimens. Specimens were saturated by the back pressure method and tested under a confining pressure equal to the effective overburden pressure. Permeability was determined by using the constant head permeability test as adapted to triaxial equipment. All permeability results are summarized in Table 9.

5.3.7 Compaction Tests

Compaction tests were made in accordance with ASTM D 1557 on selected samples representative of the upper soils that could be excavated and used as a fill material. The curves of dry unit weight versus moisture content are presented, along with the Zero air voids curve in Appendix C.

6.0 SOIL PROPERTIES FOR DESIGN

6.1 INTRODUCTION

In this section, the results of laboratory tests are discussed along with the ranges and recommended design values of soil properties. The generalized design values are believed to be conservative for the entire site. Higher values may be justified based on a localized evaluation of subsurface conditions and on the nature of the engineering problem under consideration. The recommended design properties of the site soils are compiled in Table 10.

6.2 INTERPRETATION OF LABORATORY TEST DATA

6.2.1 Natural Moisture Content and Dry Unit Weight

The natural moisture content and dry unit weights for the entire site have been plotted in Figure 18. In addition, for each sample, the corresponding total unit weight has also been calculated and presented. Although the figure for moisture content shows a fairly narrow range at all depths, there is considerably more scatter in the measured dry unit weight, thus producing a moderate scatter for the total unit weight. The design value for total unit weight versus depth has been based upon the predcminant density at each depth with appropriate consideration fcr the scatter. Generally, as shown in Figure 18, a constant value of total unit weight can be used for each major stratum. Following are the ranges and recommended design values for each major stratum:

	Ranges of Natural Properties			
Depth (Ft)	Dry Density (PCF)	Moisture Content (%)	Total Density (PCF)	Design Total Density (PCF)
0-20	95-105	22-34	115-133	125
20-50	80-90	30-45	110-125	115
50-110	95-105	15-30	120-130	125
110+	80-100	20-40	110-124	120

The scatter in dry unit weights below a depth of 110 feet as shown in Figure 18, is likely due to the presence of a slightly higher percentage of sand in some of the samples at this depth.

6.2.2 Atterberg Limits

Atterberg limits results are presented in Figures 19 and 20. Figure 19 contains three plasticity charts showing values of plasticity index (PI) and the liquid limit (LL) for the upper, middle, and lower strata. As shown in this figure, the upper stratum is the most plastic and the lower stratum the least plastic. This is attributed to the higher silt and sand content of the lower stratum. Ranges of liquid limit, plastic limit (PL), and plasticity index were derived for each of the three strata.

Depth	LL	PL	PI
0-20	39-63	17-26	18-39
20-50	35-55	16-25	15-32
50+	20-55	12-25	8-31

Figure 20 shows the plasticity ranges and the corresponding moisture content versus depth for the main plant area, the main coal storage area, and the dock area. The figure shows that the plasticity characteristics of these three areas are similar.

6.2.3 Mechanical Analysis

This site is predominantly a clay site with the exception of the 60 foot thick sand deposit above rock in the vicinity of the main plant. Localized sand and silt lenses of nominal thickness were also found at variable locations and elevations throughout the site.

Grain size distribution curves for the upper, middle, and lower strata are shown on Figures 21 and 22. Figure 22 further subdivides the grain size distribution curves of the lower stratum for five major areas of the site.

Nearly uniform conditions were encountered in the upper stratum with very little evidence of sand. This is shown in Figure 21 by the very close grouping of the grain size distribution curves within the clay size range.

Below 20 feet, a significantly greater percentage of sand size particles is apparent from Figures 21 and 22. Figures 21 and 22 show that in general, the cohesive soils within the middle and lower strata do not contain more than about 40 percent sand, and most have no more than 20 to 30 percent sand.

The grain size results for the site are presented in Figure 23 in a different manner. This figure is a presentation of the mean grain diameter D•• versus depth. It shows that, above the 90 to 100 foot depth, the majority of the data points fall within the clay and silt range while, below the 90 to 100 foot depth, the majority of the data points fall within the silt and sand ranges.

6.2.4. Activity of Clay

The activity of a clay is determined by plotting the plasticity index versus the percent of clay size particles less than two microns on an activity chart as shown in Figure 24. The figure shows that the activity values of the different samples represented are generally similar, making it possible to fit a single straight line through all the data. This line has a slope of 0.4 indicating the activity. The values generally ranged between 0.3 and 0.5. These activity values put the clays at the site in the inactive category according to Skempton (Ref 10).

6.2.5 Undrained Shear Strength

The results of all unconfined and unconsolidated-undrained compression tests along with all of the laboratory vane shear tests are combined in Figure 25. This figure shows the results of each type of test with a different symbol. Other than for the upper stratum where the unconsolidated-undrained shear strengths were somewhat higher, all three types of tests gave comparable results. The shear strength was also evaluated for each major area separately (dock, coal hopper, main plant); however, it was found that the generalized interpretation shown by the dashed line in Figure 25 is conservative and representative for all areas.

The shear strength results from previous borings in the St. Clair Power Plant area are presented in Figure 26. The interpretations of the two sets of data shown in Figures 25 and 26 are superimposed in Figure 27 for comparison. This figure shows that the strength values obtained from the two separate investigations are in good agreement.

In addition, the empirical Skempton relationship:

$$S_u/\bar{P} = 0.1 + 0.004 \text{ PI} \qquad (1)$$

has been used to calculate the undrained shear strength (S_u) for known values of plasticity index under two overburden pressure ($\bar{P}$) conditions. One assumption is that $\bar{P}$ is equal to the effective overburden pressure (Figure 28a) and the other assumes that $\bar{P}$ is equal to the overconsolidation pressure determined by Casagrande's Method (Figure 28b). These assumptions give the anticipated upper and lower boundaries of undrained shear strength as determined by this relationship. The range of plasticity index for the soils tested during this investigation (Section 6.2.2) fall within the range of applicability of Equation 1 as shown in Reference 8.

The design recommendations presented below were based on the results shown in Figure 25 with consideration of the results of previous investigations (Figure 26) and the empirical undrained shear strength values obtained from the Skempton relationship (Figure 28).

Stratum	Depth Below Ground Surface (Feet)	Peak Undrained Shear Strength (psf) Effective Range	Design Value
Upper	0-20	1,100-3,000	550
Middle	20-50	350-1,500	550
Lower	50-90	500-3,000	1,000
	90+	500-1,500	850

The basis for the selection of the design undrained shear strength for the upper stratum is discussed below.

6.2.5.1 Upper Stratum

Based upon the laboratory test results from this investigation, the undrained shear strengths for the upper stratum were found to range between 1,100 and 3,000 psf. The most predominant value of undrained shear strength was approximately 2,000 psf. These undrained shear strengths generally tend to decrease with depth which is indicative of a clay preconsolidated by dessication.

However, it should be emphasized that for preconsolidated clays having overconsolidation ratios of four to eight as in this case, the peak undrained shear strength often cannot be depended upon. The laboratory peak strength for soils of this type will give higher undrained shear strength than that which will actually develop in the field under long term conditions. This is because high negative pore pressures develop during shearing of the soil in the laboratory (Ref 11) and these are not expected to develop to the same extent or remain for any long period of time in the field. In addition, as the soil dries out (desiccates), the soil contracts and shrinkage cracks form within the desiccated layer. This allows failure to occur on pre-formed failure planes and the full undrained strength of the soil is not developed. For this situation, the available long term strength is closer to the residual strength (Ref 12).

In evaluating the shear strength to be used for the upper stratum, the typical shape of the stress-strain curves during failure of the sample was also considered. These curves are shown for each sample on pages C-271 through C-341 of Appendix C in Volume 2. The curves show a "brittle" soil which reaches its maximum strength at relatively low strain (2-5%), at which point the strength drops off fairly rapidly. This stratum will reach its maximum strength first with respect to the lower stratum, if subjected to the same strain.

It should be noted however that the reduction in strength with increasing strain was noted primarily in the unconfined compression tests which represented the majority of available data. This strength reduction is partially caused by the lack of sample confinement inherent in the test.

Considering all of the above factors, a design shear strength of 550 psf is recommended for the upper stratum. This value is approximately one half the lower bound strength predicted from the laboratory tests. Values up to 1100 psf may be justified in some situations.

Comparing the above laboratory test results with the empirical shear strength values obtained by the Skempton procedure, the average undrained shear strength for the stratum would range between 250 psf, for a normally consolidated soil (Figure 28a), to 1,000 psf for an overconsolidated soil (Figure 28b). It should be noted, however, that the values of shear strength are influenced by the effective overburden or preconsolidation pressure substituted into the Skempton relationship. In reality, the shear strength for the upper stratum will be higher than that indicated in Figure 28a for a normally consolidated soil. This is primarily because of the influence of the shallow depth and the preconsolidated nature of this stratum. Since this stratum is cverconsolidated, the empirical shear strength value of 1,000 psf, as shown in Figure 28b, should be closer to the actual shear strength.

Although higher shear strengths were obtained from undrained shear strength testing, the higher values cannot be recommended because of the potential pre-formed failure planes and also the relatively high negative pore pressures that develop in testing but do not exist to the same degree in the field. Both of these tend to decrease the measured shear strength, although the amount of decrease cannot be adequately determined. Thus, a value of 550 psf is recommended primarily based upon the residual shear strengths obtained from unconsolidated-undrained shear strength testing and the results of triaxial testing.

6.2.5.2 Middle Stratum

The middle stratum has been found to be the weakest stratum at this site. Undrained shear strengths based on laboratory test results range from 300 tc 1,000 psf with the most predominant value being 550 psf. Unlike the upper stratum, the stress-strain curves for this stratum typically peak at low strains (about 2%) with only a slight reduction in strength at higher strains. As shown in Figure 25, the shear strength from test results can be taken as approximately constant with depth at 550 psf over the range of 20 to 50 feet. This value is recommended for design. The strength of 550 psf was found to be within the range obtained from the Skempton's relationship utilizing both the effective overburden pressure and preconsolidation pressure (Figure 28a and b, respectively).

If normally consolidated conditions are assumed as shown in Figure 28a, the resulting shear strength is very nearly equal to that obtained by laboratory testing. The figure shows a gradual increase in shear strength with depth ranging from about 400 psf at a depth of 20 feet to about 650 psf at a depth of 50 feet. This increase is imposed by the nature of Skempton's relationship and should be expected for normally consolidated clays if perfect samples are obtained. The laboratory results do not show this trend, and this is an indication of sample disturbance. A slightly higher shear strength is obtained when the preconsolidation pressures are used as shown in Figure 28b: the average shear strength decreases from 900 psf at a depth of 20 feet to 800 psf at a depth of 50 feet. This reduction in strength with depth is caused by the reduction in preconsolidation pressure determined from consolidation testing.

6.2.5.3 Lower Stratum

The lower stratum can be taken as beginning at a depth of approximately 50 feet and extending to bedrock at depths ranging from approximately 125 to 145 feet. This stratum may be further subdivided into two layers as far as the undrained shear strength is concerned.

6.2.5.3.1 Layer From 50-90 Feet

As shown in Figure 25, distinctly higher shear strengths were obtained from depths of 50 to 90 feet. The soils in this layer are considered to be moderately overconsolidated. Comparing the natural moisture content and dry unit weight in this layer with the layer below, the natural moisture content did not decrease significantly with increasing depth nor did the dry unit weight increase significantly with increasing depth. Thus, it is possible that this layer was also preconsolidated by desiccation, although the trend in shear strength variation with depth does not provide enough evidence to conclude this.

A fairly wide range of laboratory shear strengths was obtained as shown in Figure 25. These values ranged from about 500 to 3,000 psf with approximately two-thirds of the data ranging between 500 and 1,500 psf and the other third between 1,500 and 3,000 psf. The most predominant value between 500 and 1,500 psf was 1,000 psf. As shown in Figure 28, the estimated shear strength at a depth of 50 feet, based on the Skempton statistical procedure, was found to be either 650 or 850 psf, depending on whether normally consolidated or overconsolidated conditions are assumed. Both procedures give a shear strength of approximately 1,000 psf at a depth of 90 feet.

Typical stress-strain curves for soils between 50 and 90 feet either remain constant with strain near the peak stress or drop somewhat as can be seen on pages C-271 thru C-341 of Appendix C in Volume 2. However the drop in stress occurred at a higher strain in the range of 10-12%.

Considering the higher strain at which the peak soil strength occurs and not discounting completely the lower shear strengths as predicted by the Skempton procedure, the shear strength of 1,000 psf is recommended for this layer.

6.2.5.3.2 Soils Below 90 Feet

Indications are this layer is normally to very slightly overconsolidated. Based upon the laboratory test results, the shear strength in this layer ranges between 500 and 1,500 psf with an average of approximately 850 psf. The decrease in undrained shear strength, as compared to the layer above, was also noted in the laboratory test results obtained from the previous investigations. Figure 26 shows values of shear strength between 200 and 1,000 psf with an average of 600 psf.

Comparison of the strength predicted from Skempton's equation (Figure 28) and the strength data in Figure 25 shows that the upper bound of the laboratory strength (1,500 psf) is close to the strength predicted by the Skempton equation. However, it should be noted that in this case, the Skempton procedure is also influenced by the greater depth (the actual value of the effective vertical pressure), and it is possible that the actual shear strength may be lower than predicted by this method.

The actual shear strength reduction associated with the soil below 90 feet may be due to several causes, the most plausible of which is sample disturbance. This was borne out by running both undisturbed and remolded unconfined compression tests (at the same moisture content and dry density) on the same sample, see Tables 2 and 3. The ratio between these two tests (undisturbed strength divided by remolded shear strength) is called sensitivity. These tables show that the sensitivity of the site soils was generally between 1.0 and 1.5. This is another indication that, but not necessarily a conclusion that, the samples have been disturbed.

One additional consideration in explaining the reduced strengths at great depths is the amount of sand present (Figures 21, 22, and 23). This could cause a reduction of the laboratory strength in unconfined compression tests.

Since the standard penetration blowcounts do not decrease within this depth (Figure 17), and the Skempton empirical relationship shows a high strength, the average strength of 850 psf obtained from laboratory tests is considered conservative and is recommended for the soils below 90 feet.

6.2.6 Shear Strength From $\overline{CU}$ Tests

The long term (drained) shear strength has been determined by consolidated-undrained triaxial tests with pore pressure measurements. In addition to the Mohr-Coulomb envelopes for total and effective stresses, the deviator stress, effective stress ratio, change in pore pressure, and Skempton's A parameter have also been plotted versus strain and are included in Appendix C of Volume 2. The failure criteria presented was based on the peak deviator stress. If a maximum stress ratio failure criteria is desired, it can be readily obtained.

In order to evaluate the total and effective stress parameters, the stress point or "p-q" diagram as suggested by Lambe and Whitman (Ref 13) has been used. These diagrams are shown in Figures 29 and 30 for total and effective stress parameters, respectively. These figures show that the "p-q" diagram for effective and total stress can be idealized by two straight lines intersecting at a pressure corresponding to a depth in the range of 55 to 62 feet. This depth also corresponds to the division between the middle and lower stratum. The "p-q" diagrams are used to calculate the effective and total stress parameters required to determine shear strength from the Mohr-Coulomb relationships (Ref 13).

The Mohr-Coulomb relationship for effective stresses is given by:

$$\tau = c' + \sigma' \tan \phi' \qquad (2)$$

Where τ = drained shear strength

σ' = effective normal stress on failure plane at failure

c' = cohesion intercept for effective stresses

ϕ' = angle of internal friction for effective stresses,

and the Mohr-Coulomb relationship for total stresses is given by:

$$S = c + \sigma \tan \phi \qquad (3)$$

where S = shear strength

σ = total normal stress on failure plane at failure

c = cohesion intercept for total stresses

ϕ = angle of internal friction for total stresses.

Recommended values of effective and total stress parameters for each stratum are given below:

	Total Stress Basis		Effective Stress Basis	
Depth (Ft)	ϕ	c (PSF)	ϕ'	c' (PSF)
0-20	13°	450	28°	0
20-50	13°	450	28°	0
50+	10°	700	22°	250

6.2.7 Tangent Modulus of Elasticity

The initial modulus of elasticity has been plotted versus depth on Figure 31 for all of the undrained shear strength tests. Although there is some scatter, a reasonable design value can be determined for each of the three strata. These values are given below and are further discussed in this section.

		Undrained Tangent Modulus E (ksf)		
Stratum	Depth (ft)	Effective Range	Average	Design Values
Upper	0-20	100-200	175	700
Middle	20-50	25-120	65	330
Lower	50+	25-240	100	550

It has been found that for settlement calculations the values obtained from undrained shear strength tests should be increased by a factor of four to five to give results that agree with measured settlements (Ref 13). The lower measured test values can be attributed to sample disturbance. Bjerrum (Ref 14) has suggested that the modulus can be obtained by multiplying the undrained shear strength by a factor of 400 to 600. However, for this site, the ratio E/S_u has been found to be approximately 100 for all of the soils tested, except the middle stratum which showed a slightly higher ratio of approximately 140. Therefore, the values of E/S_u obtained in this investigation are apparently lower by a factor of four to six than what would be generally expected. Both the modulus of elasticity and the undrained shear strength are apparently lower, with the greater reduction in the modulus of elasticity.

Therefore, an increase in the modulus of elasticity from test results by a factor of as high as four to five is justified in the average modulus of elasticity values as determined from the undrained shear strength tests. Based on this criteria, and the corresponding criteria of 400 to 600 times the undrained shear strength, initial static modulus of elasticity values of 700, 330, and 550 ksf are recommended for the upper, middle, and lower strata, respectively.

6.2.8 Consolidation

6.2.8.1 Preconsolidation Pressure

Figure 32 shows the variation of preconsolidation pressure with depth as determined by Casagrande's Procedure. Samples believed to be relatively disturbed based on the shape of the consolidation curve have been designated with a different symbol in Figure 32. Also included in this figure is a plot of moisture content with respect to Atterberg limits versus depth for all of the consolidation tests to assist in estimating the degree of overconsolidation. A natural moisture content near the plastic limit indicates an overconsolidated soil, whereas a natural moisture content near the liquid limit indicates a normally consolidated soil. These data are shown on the left side of Figure 32 for each of the consolidation test results presented. This figure shows the subsurface soils at this site are preconsolidated to some degree, for their entire depth.

To help determine a design preconsolidation pressure, Skempton's procedure has also been used to estimate the preconsolidation pressure from the plasticity index and the unconfined and unconsolidated-undrained compression tests. This interpretation is shown in Figure 33.

As shown in Figure 32, almost all of the soils at this site, with the exception of the upper stratum soils (0-20 feet) and soils from 50 to 90 feet, can be considered normally to slightly overconsolidated for design purposes. This is because of the relatively slight overconsolidation shown by consolidation tests.

The soils from 0 to 20 feet (upper stratum) have been preconsolidated by desiccation. This judgement is based primarily on the general decrease in shear strength with depth as shown in Figure 25 as opposed to soils preconsolidated by either glaciation or preloading which will have shear strengths increasing with depth.

The design preconsolidation pressure for the upper stratum has been determined by drawing the precompression line along the lower bound of preconsolidation pressure as determined by consolidation test results. This is nearly parallel to and slightly lower than the preconsolidation line as determined by the Skempton procedure (Figure 33).

Preconsolidated soils were also noted between 50 and 90 feet based on consolidation tests and the Skempton equation (Figures 32 and 33). This is also the depth range in which higher undrained shear strengths were obtained from laboratory tests (Figure 25). Although it cannot be said conclusively, it appears that the soil from 50 to 90 feet was also preconsolidated by desiccation as with the upper stratum rather than by glaciation. Since the soils below 90 feet appear to be only slightly overconsolidated at the most, desiccation appears to be the most plausible explanation for the preconsolidation.

Considering the scatter in the preconsolidation pressure based on Casagrande's Method and the predicted preconsolidation pressure based on Skempton's relationship, the recommended design curve for preconsolidation pressure is as shown in Figure 33.

6.2.8.2 Settlement Parameters

The compression index (C_c), swelling index (C_r), initial void ratio (e_o) and the settlement parameter ($C_c/1+e_o$) all versus depth are shown in Figures 34, 35, 36, and 37. The range of values is small enough that a constant value can be used throughout each major stratum, and the design curves shown are drawn to reflect this. Presented below are the ranges and recommended design values for the various parameters.

Depth (ft)	C_c Range	C_r Range	e_o Range
0-20	0.14-0.16	0.05-0.07	0.65-0.80
20-50	0.33-0.45	0.09-0.10	0.72-1.10
50+	0.18-0.41	0.05-0.08	0.60-1.00

	$C_c/1+e_o$		$C_r/1+e_o$
Depth (ft)	Range	Design	Design
0.20	0.10-0.15	0.13	0.04
20-50	0.15-0.24	0.20	0.04
50+	0.11-0.21	0.14	0.04

Values of the compression index (C_c) and the swelling index (C_r) are plotted versus liquid limit, for the soils tested, in Figure 38. The soils from the upper stratum are identified with different symbols because of the overconsolidation of this stratum. The empirical relationship:

$$C_c = 0.009\ (LL - 10) \tag{4}$$

and the plus or minus 30 percent upper and lower bounds suggested by Terzaghi and Peck (Ref 12) are superimposed in Figure 38. The compression index values (C_c) measured in this investigation compare favorably with the empirical relationship. The data for the upper stratum fall around the lower bound of this relationship, as should be expected because of the overconsolidation.

Similar results were obtained for the swelling index (C_r) values. Based on the data in Figure 38, the relationship between swelling index and liquid limit for the soils tested can be expressed by the equation:

$$C_r = 0.002\ (LL - 2.5)\,. \tag{5}$$

Figure 38 also shows an upper and lower bound representing a variation of plus or minus 30 percent from the above relationship. It was found that these lines represent good upper and lower bounds for the data.

6.2.8.3 Coefficient of Consolidation

Figure 39 shows values of the coefficient of consolidation (C_v) versus pressure for the three major strata. The relationship between C_v and the logarithm of pressure is represented by a band and an average curve for each stratum as shown in the figure. These bands and average curves conform to the general relationship presented by Lambe (Ref 15). As shown in the figure, the effective range of the coefficient of consolidation is 0.05 to 0.25 square feet per day for all samples tested over the pressures involved. An overall average of 0.15 square feet per day is recommended for design.

6.2.9 <u>Permeability</u>

Constant head permeability tests were performed on samples of silty clay taken from depths ranging from 20 to 90 feet. All samples were saturated in a triaxial cell by back pressure and tested at a confining pressure approximately equal to the effective overburden pressure. The coefficient of permeability was found to range from 1.6×10^{-8} cm/sec to 2.6×10^{-8} cm/sec for void ratios between 0.4 and 0.9. Thus, for any engineering analysis, an average permeability of 2 x 10^{-8} cm/sec may be used for the silty clays found at this site.

6.2.10 Compaction

The results of all laboratory compaction tests are shown in Figure 40. The tests were performed on samples from the upper stratum and the results grouped according to soil type. Since the soils below this depth are soft to very soft, only the upper stratum is expected to be used for fill material. The zero air void curves (100% saturation) were plotted assuming specific gravities of 2.70 and 2.75. The two diagrams on the left side of the figure (CL and CH soils) show results from samples taken northwest of the plant site near the intersection of King and Puttygut roads. This is within the proposed fly ash disposal area and is a potential borrow area for the remainder of the plant. The diagram on the right side of this figure (CL-CH soils) shows results from samples taken in the vicinity of the proposed main coal pile.

Since the most predominant natural moisture content for the upper stratum soils is about 26%, this indicates that on the order of 10% to 16% reduction in moisture content will be necessary to compact these soils to the maximum dry density, and approximately 6% to 10% reduction will be necessary to obtain 95% of the maximum. Because of the relatively large amount of drying required, compaction of these soils will be difficult.

7.0 SUMMARY AND CONCLUSIONS

An extensive subsurface investigation program was conducted at the Belle River Project site. The investigation consisted of geologic studies, ground water measurements, soil/rock borings, and laboratory soil testing, along with an evaluation of previous investigations at the site. The subsurface investigation was directed at confirming the suitability of the site and providing generalized soil parameters and information for design of the various plant facilities.

The investigation showed that:

a. Geologic and subsurface soil conditions at the site are suitable for the development of the site.

b. Ground water information, based on four observation wells monitored for a period of one year, have been accumulated and presented.

c. The soil parameters for design and construction evaluations have been developed in the report and are further summarized in the Tables. The results are considered to be conservative and are applicable for the entire site. Soil boring logs showing the pertinent soil parameters are also presented in Appendix B.

Depending on the engineering problem under consideration, localized and more extensive evaluations or investigations may be required to expand upon the available information.

8.0 REFERENCES

1. R. J. Brigham, "Structural Geology of Southwestern Ontario and Southeastern Michigan," Ontario Department of Mines and Northern Affairs, Petroleum Resources Section, Paper 71-2, 1971.

2. S. T. Algermissen, Seismic Risk Studies in the United States (1969), National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D. C.

3. J. A. Door, Jr. and D. F. Eschman, Geology of Michigan, The University of Michigan Press, Ann Arbor, 1971.

4. J. H. Fisher (chairman), Stratigraphic Cross-Sections, Michigan Basin (1969), Michigan Basin Geological Society.

5. G. D. Ells and B. L. Champion (compilers), Michigan's Oil and Gas Fields 1972, Annual Statistical Summary No. 18 (1973), Michigan Department of Natural Resources, Geological Survey Division.

6. R. L. Knutilla, Gazetteer of Hydrologic Data for the Belle River Basin, Southeastern Michigan, (1969), Southeastern Michigan Water Resources Study, Technical Paper No. 2, U. S. Geological Survey, Water Resources Division.

7. L. Panek, (Personal Communication), U. S. Bureau of Mines, Mining Research Center, Denver, Colorado.

8. A. W. Skempton, "Discussion: The Planning and Design of the New Hong Kong Airport," Proceedings of the Institution of Civil Engineers, Vol. 7, London, 1957, p. 305-307.

9. D. M. Burmister, "The Application of Controlled Test Methods in Consolidation Testing: Symposium on Consolidation Testing of Soils," ASTM Special Technical Publication 126, 1951, p. 83.

10. A. W. Skempton, "The Colloidal Activity of Clays," Proceedings of the 3rd International Conference of Soil Mechanics and Foundation Engineering, Vol. I, Switzerland, 1953.

11. G. A. Leonards, Editor, Foundation Engineering, McGraw Hill, New York, 1962.

12. K. Terzaghi and R. B. Peck, Soil Mechanics in Engineering Practice, 2nd Editicn, John Wiley & Sons, Inc., New York, 1967.

13. T. W. Lambe and R. V. Whitman, Soil Mechanics, John Wiley & Sons, Inc., New York, 1969.

14. L. Bjerrim, Unpublished Lecture on Observed Versus Computed Settlements of Structures on Clay and Sand, Given at Massachusetts Institute of Technology, 1964.

15. T. W. Lambe, Soil Testing for Engineers, John Wiley & Sons, Inc., New York, 1951.

TABLES

TABLE 1

GAS ENCOUNTERED IN DRILL HOLES

Drill Hole No	Depth to Gas Infiltration (ft)	Soil Type	Remarks
12	118.0	Sand	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
20	136.0	Sand	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
30	50.0	Clay	Bubbles in drill fluid, gas dissipated after 48 hours, no odor
50	98.0	Clay	Bubbles in grout after pulling casing, gas dissipated after 24 hours, no odor
52	70.5	Sand	Bubbles in grout after pulling casing, gas dissipated after 24 hours, no odor
59	124.5	Silt	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
131	104.0	Sand	Drill fluid ejected several feet above drill hole, gas dissipated after 6 hours, no odor

TABLE 2

UNCONFINED COMPRESSION TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET) FROM	DEPTH (FEET) TO	UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN 4	10	20	40	100	200	2µ	SPECIFIC GRAVITY	ATTERBERG LIMITS LL	PL	PI	NATURAL CONDITIONS W_o %	γ_d PCF	γ_t PCF	UNCONFINED COMPRESSION TEST RESULTS S_u PSF	E 10^3 PSF	ε %	E/S_u —	REMARKS
15/4	8.6	8.9	CL									44	19	25	32	93	123	1257	156	6.0	127	
15/6	18.1	18.4	CL									42	20	22	34	87	117	508	25	15.0	69	
15/14	59.2	59.6	CL									34	18	16	23	104	128	1067	31	15.2	36	
25/1	4.5	4.8	CH									59	23	36	22	108	132	3456	174	5.0	50	
26/9	39.4	39.7	CL									38	20	18	37	86	118	445	67	1.6	151	
26/17	78.2	78.5	CL									36	20	16	25	101	126	580	22	12.0	38	Sandy
27/4	8.6	8.9	CL-CH									51	23	28	31	94	123	1722	58	15.0	34	
28/3	5.8	6.1	CL									47	23	24	25	100	125	1981	222	4.0	112	
28/9	28.8	29.1	CL									42	20	12	38	84	116	425	57	7.0	134	
38/3	8.7	9.0	CL-CH	--	--	--	--	--	97	61	2.70	49	24	25	24	102	126	2122	267	3.0	126	
38/4	14.3	14.6	CL-CH	--	--	--	--	--	97	61	2.71	46	22	24	29	96	124	1505	125	4.0	83	
38/12	54.2	54.5	CL-CH	--	--	--	--	--	98	55	2.70	44	21	23	33	90	120	985	105	5.0	107	
38/16	73.7	74.0	CL-CH	--	--	--	--	--	97	63	2.72	55	24	31	41	79	111	703	41	4.8	58	
38/18	84.6	84.9	CL	--	--	--	--	--	97	47	2.70	33	19	14	22	104	127	603	33	14.0	55	Gravelly
38/24	114.2	114.5	CL	--	--	--	--	--	99	61	2.70	45	25	20	32	92	121	500	63	6.0	126	
41/2	4.5	4.8	CH	--	--	--	--	--	98	63	2.70	63	28	35	29	94	121	1024	143	5.0	140	
41/7	20.6	20.9	CL-CH	--	--	--	--	--	99	57	2.66	47	24	23	39	83	115	338	357	3.0	1056	
41/9	30.9	31.2	CL-CH									45	21	24	37	86	118	697	67	15.0	96	
41/11	40.6	41.0	CL-SC	--	92	86	80	68	58	17	2.70	20	12	8	16	118	137	647	25	15.0	39	Sample slightly disturbed.
41/23	101.8	102.1	CL	--	--	--	--	--	95	47	2.70	34	20	14	26	99	125	534	67	10.0	125	Sandy
41/29	130.7	131.0	GC-SC	--	96	90	80	65	57	23	2.69	25	17	8	14	124	141	1749	154	8.0	88	
48/2	3.2	3.5	CH									63	24	39	27	97	123	1466	137	3.2	93	
48/14	61.2	61.5	CL									34	16	18	25	100	125	745	22	15.0	30	Sandy
49/4	24.0	24.3	CL									42	22	20	34	90	121	1028	69	6.0	67	

TABLE 2

UNCONFINED COMPRESSION TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN							SPECIFIC GRAVITY	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONFINED COMPRESSION TEST RESULTS				REMARKS
	FROM	TO		4	10	20	40	100	200	2μ		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	S_u PSF	E 10^3 PSF	ε %	E/S_u	
49/9	73.9	74.3	CL									33	22	11	26	100	126	2254	100	15.0	36	Sandy
50/6	29.3	29.7	CH-CL	--	--	--	--	--	97	53	2.70	51	18	33	46	75	110	197	45	2.4	228	
50/8	38.9	39.2	CH									55	23	32	51	70	106	550	113	2.0	205	
50/10	49.0	49.3	CL	99	96	94	92	86	81	37	2.70	36	16	20	24	99	123	526	39	15.0	74	Sandy
50/12	58.6	58.9	CL									39	18	21	26	99	125	1007	200	9.0	199	
50/16	78.6	78.9	CL									39	20	19	28	95	122	1270	161	10.0	127	
52/3	20.5	20.9	CL-CH									49	20	29	30	92	120	2737	263	4.0	96	
52/4	28.6	28.9	CL									35	18	17	32	94	124	489	61	9.0	125	
52/6	49.2	49.5	CL-ML									22	18	4	25	100	125	317	100	2.5	315	
52/7	59.0	59.3	CL	97	94	87	83	72	58	16	2.70	23	14	9	13	116	131	1798	150	6.0	83	Sandy
52/8	68.2	68.5	CL									24	14	10	14	115	131	1676	133	13.0	79	Sandy
52/10	88.6	88.9	CL									39	18	21	27	97	123	2435	230	8.0	94	Sandy
53/3	19.6	19.9	CL-CH									49	20	29	32	88	116	1155	172	5.0	149	
53/4	29.6	29.9	CL-CH									49	22	27	40	80	112	1006	200	5.0	199	
53/6	49.2	49.5	CL									43	18	25	28	94	120	561	65	15.0	116	
53/9	80.1	80.4	CL									39	21	18	26	99	125	1275	182	6.0	143	
54/5	59.3	59.6	CL									38	17	21	26	99	125	557	114	11.0	205	Sandy
54/7	68.5	68.8	CL									37	18	19	26	98	123	788	58	8.9	74	Sandy
59/3	18.8	19.1	CL-CH									48	20	28	33	90	120	1056	107	6.9	101	
59/5	38.7	39.0	CL									38	18	20	26	99	125	625	104	14.9	166	Sandy
59/7	58.6	58.9	CL									36	18	18	26	98	123	835	200	8.0	240	Sandy
60/3	17.6	18.0	CL	--	--	--	--	--	98	52	2.70	39	21	18	24	105	130	1143	26	15.0	23	
60/5	25.6	25.9	CH									51	22	29	37	86	118	1001	143	4.0	143	
60/6	30.5	30.8	CL-CH									48	25	23	35	88	119	3153	222	3.7	141	
																						Sheet 2 of 3

TABLE 2

UNCONFINED COMPRESSION TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN							SPECIFIC GRAVITY	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONFINED COMPRESSION TEST RESULTS				REMARKS
	FROM	TO		4	10	20	40	100	200	2μ		LL	PL	PI	w_o %	γ_d PCF	γ_t PCF	S_u PSF	E 10^3 PSF	ε %	E/S_u ———	
60/8	40.6	41.0	CL									47	25	22	40	83	116	337	50	3.0	148	
60/10	50.9	51.2	CL									34	16	18	26	100	126	1255	75	15.0	60	
60/11	55.6	56.0	CL	95	89	86	84	79	76	34	2.70	33	18	15	25	103	129	1299	133	15.0	102	Sandy
60/14	75.1	75.4	CL									40	20	20	27	97	123	651	71	5.0	109	
60/19	100.1	100.4	CL									38	20	18	27	101	128	1131	100	7.0	88	Sandy
60/23	119.6	120.0	CL-ML	--	94	90	86	71	61	18	2.70	17	11	6	15	115	132	335	55	6.0	164	Sandy
101/2	8.9	9.2	CL-CH									50	22	28	28	96	123	1828	200	2.4	109	
101/4	19.6	20.2	CL-CH									49	24	25	36	86	117	1014	75	6.0	74	
101/7	34.9	35.2	CL-CH									46	24	22	40	81	113	795	55	2.4	76	
101/10	50.1	50.4	CL-CH									40	22	18	33	90	120	722	71	5.0	89	
101/13	65.2	65.6	CL									36	19	17	27	97	123	1337	43	15.0	32	
101/17	85.2	85.5	CL									37	19	18	25	97	121	1923	102	15.0	53	Sandy
119/9	81.6	81.9	CL									33	20	13	21	107	129	3072	111	15.0	36	Sandy
126/3	8.2	8.6	CL-CH									47	24	23	26	99	125	1725	208	2.4	121	
136/4	8.8	9.2	CL-CH									48	22	26	24	102	126	5446	769	3.0	141	
144/4-1	8.5	8.8	CL-CH									48	21	27	26	97	122	861	192	1.7	223	
144/4-2	8.9	9.2	CL-CH									48	21	27	24	99	123	1002	119	3.0	119	
185/3	7.5	7.8	CL-CH									50	23	27	24	104	129	2947	400	4.0	136	
185/7	18.5	18.8	CL-CH									49	22	27	39	81	113	831	94	2.4	113	

TABLE 3

UNCONFINED COMPRESSION TEST RESULTS

REMOLDED AND COMPACTED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN							SPECIFIC GRAVITY	ATTERBERG LIMITS			PRE TEST CONDITIONS			UNCONFINED COMPRESSION STRENGTH TEST			REMARKS
	FROM	TO		4	10	20	40	100	200	2μ		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	S_u PSF	E 10^3 PSF	ε %	
38/3	8.7	9.0	CL-CH	-	-	-	-	-	97	61	2.71	49	24	25	24	103	128	761	46	7.0	Remolded
38/18	84.6	84.9	CL	-	-	-	-	-	99	61	2.70	33	19	14	22	105	128	547	27	17.4	Remolded
41/2	4.5	4.8	CH	-	-	-	-	-	98	63	2.70	63	28	35	29	95	123	962	80	9.0	Remolded
60/3	17.6	18.0	CL	-	-	-	-	-	98	52	2.70	39	21	18	24	103	128	1,052	13	15.0	Remolded
60/11	55.6	56.0	CL	95	89	86	84	79	76	34	2.70	33	18	15	25	103	129	817	13	15.0	Remolded
127/3	5.6	7.0	CL-CH									49	22	27	14	113	129	9,403	869	3.2	Compacted (97% ASTM D1557)
136/6	13.0	14.6	CL									43	22	21	18	100	118	2,773	400	2.0	Compacted (89% ASTM D1557)
141/2	8.0	10.0	CL-CH									49	23	26	18	103	122	5,558	592	2.0	Compacted (90% ASTM D1557)
144/4	8.0	10.0	CL-CH									-	-	-	24	100	124	1,482	58	15.0	Remolded
146/7	14.0	16.1	CL									46	22	24	17	104	122	3,282	484	2.0	Compacted (85% ASTM D1557)
158/2	7.5	9.7	CL-CH									50	21	29	17	104	122	3,416	481	2.0	Compacted (87% ASTM D1557)

NOTE: Remolded samples run at same dry density and water content as undisturbed samples.

TABLE 4

LABORATORY VANE SHEAR TEST RESULTS

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			PRETEST CONDITIONS			UNDRAINED STRENGTH UNDISTURBED		UNDRAINED STRENGTH REMOLDED		SENSITIVITY	REMARKS
	FROM	TO		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	COHESION PSF	ANGLE OF ROTATION DEGREES	COHESION PSF	ANGLE OF ROTATION DEGREES	UNDISTURBED STRENGTH DIVIDED BY REMOLDED STRENGTH	
50/6	28.1	28.3	CL	39	18	21	35	82	111	479	8	178	7	2.7	
50/10	48.1	48.4	CL	36	16	20	26	96	121	520	32	480	52	1.1	
52/4	28.9	29.2	CL	35	18	17	31	89	117	560	10	266	7	2.1	
52/6	49.6	49.8	CL	-	-	-	24	101	125	2,165	30	-	-	-	
52/10	89.1	89.4	CL	39	18	21	26	96	121	1,660	15	1,525	51	1.1	
53/6	49.7	50.0	CL	43	18	25	27	94	119	520	13	312	40	1.2	
53.9	79.5	79.8	CL	39	21	18	28	95	122	1,375	22	-	-	-	
54/5	59.7	60.0	CL	38	17	21	28	92	118	1,200	54	-	-	-	
59/3	18.5	18.8	CL-CH	48	20	28	33	90	120	1,250	15	-	-	-	
59/5	39.4	39.7	CL	38	18	20	26	96	121	640	15	-	-	-	
59/7	59.0	59.3	CL	36	18	18	24	102	127	735	22	-	-	-	

TABLE 5

UNCONSOLIDATED-UNDRAINED TRIAXIAL TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONSOLIDATED UNDRAINED STRENGTH TEST					REMARKS
							W_o	γ_d	γ_t	σ_o	S_u	E	ε	E/S_u	
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	PSF	10^3 PSF	%	——	
15/2	3.7	4.1	CL	45	21	24	25	101	126	475	2386	240	8.0	101	
18/3	20.6	20.9	CL	44	21	23	40	83	116	2448	410	150	4.0	366	
18/6	51.4	51.7	CL	39	18	21	31	92	121	4104	827	100	3.0	121	
18/10	88.8	90.1	CL	29	15	14	17	111	130	6336	2862	240	15.0	84	Sandy
25/10	88.9	89.2	CL	36	19	17	23	104	128	6192	2213	162	11.0	73	
27/2	4.5	4.8	CL-CH	48	24	24	24	103	129	576	2099	121	8.0	58	
41/17	72.9	73.2	CL	25	15	10	20	105	126	8654	453	21	14.0	46	Sandy
48/14	60.8	61.1	CL	34	16	18	26	99	125	4608	746	36	15.0	48	Sandy
50/8	38.1	38.4	CH	55	23	32	46	74	108	3456	643	75	4.0	117	
50/10	49.3	49.6	CL	36	16	20	23	100	123	4320	721	73	15.0	101	Sandy
50/12	59.1	59.4	CL	39	18	21	24	101	125	4608	1132	218	10.0	193	Sandy
52/3	21.2	21.5	CL-CH	49	20	29	31	92	121	2016	1590	157	8.0	99	
52/8	69.0	69.4	CL	24	14	10	16	111	129	5184	1890	127	15.0	66	Sandy
52/9	78.6	78.9	CL	35	18	17	22	105	128	5760	1156	130	14.0	112	
52/12	109.3	109.6	CL	46	22	24	36	87	118	7632	1586	230	3.0	145	
53/3	20.1	20.4	CL-CH	49	20	29	32	91	120	2405	1425	176	8.9	124	
53/4	30.1	30.4	CL-CH	49	22	27	34	88	118	3024	972	200	2.4	206	
54/4	53.2	53.5	ML-CL	21	17	4	24	99	123	4320	533	54	15.0	101	
54/5	59.0	59.3	CL	38	17	21	25	99	124	4464	767	35	15.0	46	Sandy
54/6	63.1	63.4	CL	36	18	18	26	98	123	5040	796	100	13.0	126	Sandy
54/7	68.8	69.1	CL	37	18	19	26	98	123	5112	1148	142	12.0	124	Sandy
101/15	74.6	74.9	CL	36	21	15	23	105	129	5328	1054	44	15.0	42	Sandy
101/19	94.9	95.3	CL	36	20	16	25	100	125	6480	547	32	15.0	59	
101/23	119.8	120.2	CL	44	22	22	37	85	116	7920	721	70	8.0	97	
															Sheet 1 of 2

TABLE 5

UNCONSOLIDATED-UNDRAINED TRIAXIAL TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONSOLIDATED UNDRAINED STRENGTH TEST					REMARKS
	FROM	TO		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	σ_o PSF	S_u PSF	E 10^3 PSF	ϵ %	E/S_u	
126/11	49.1	49.4	CH	59	25	34	41	81	114	4032	498	50	4.0	100	
126/23	108.6	108.9	CL	36	20	16	25	96	120	7200	1344	60	15.0	45	
129/3	8.7	9.0	CL-CH	48	23	25	22	108	132	1080	3381	250	6.0	74	
129/15	74.0	74.3	CL	36	21	15	25	101	126	5760	954	62	7.0	65	
129/24	124.1	124.4	CL-CH	46	22	24	31	95	124	7920	679	30	8.0	44	
151A/3	13.0	13.3	CL-CH	48	20	28	28	95	122	1555	2325	167	10.0	72	

TABLE 6

CONSOLIDATED-UNDRAINED TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S $\bar{A}$ PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS			
																	TOTAL STRESS		EFFECTIVE STRESS	
	FROM	TO		LL	PL	PI	W_o	γ_d	γ_t	$\bar{\sigma}_3$	W_f	γ_{tf}	E	$(\sigma_1-\sigma_3)^1$	E/S_u		ϕ	C	ϕ'	C'
							%	PCF	PCF	PSF	%	PCF	10^3 PSF	PSF	——		deg.	PSF	deg.	PSF
18/12	108	110	CL	46	22	24	35	87	117	3,744	33.7	116	316	3,900	161	0.28	10	900	22	300
							31	92	120	7,488	29.3	119	400	5,200	154	0.68				
							31	92	120	15,120	27.7	117	1,500	8,170	367	1.04				
26/2	3.5	5.5	CL-CH	53	24	29	23	104	127	360	27	132	225	2,200	204	0.15	34	350	27	320
							24	103	128	691	27	131	346	3,450	200	0.19				
							22	108	132	1,296	25	135	450	4,800	187	0.20				
26/5	18	20	CL-CH	--	--	--	35	89	120	1,080	31	116	125	1,350	185	0.23	16	250	27	50
							35	86	116	2,160	31	113	273	1,680	325	0.72				
							36	86	117	5,040	28	110	500	4,350	230	0.56				
26/11	48	50	CL	41	21	20	36	88	120	2,304	34	118	250	1,790	279	0.57	9	400	24	0
							37	86	118	4,608	23	106	666	2,440	546	1.11				
							30	93	121	9,216	24	115	666	4,410	302	1.34				
33/7	28	30.5	CL	46	22	24	39	82	114	1,440	37	112	300	1,480	405	0.39	10	300	24	0
							40	82	115	2,880	37	112	750	1,930	776	0.77				
							38	84	116	5,760	32	111	500	3,040	328	1.17				
33/9	38.0	40.5	CL	43	23	20	37	83	114	7,200	36	113	175	1,600	110	0.51	9	400	22	150
							37	85	116	7,200	34	114	300	2,160	277	0.93				
							36	86	117	12,960	31	113	300	3,320	180	1.31				
48/6	18.0	20.0	CL-CH	47	25	22	33	90	120	1,152	32	119	166	1,860	179	0.05	9	700	21	300
							34	89	119	2,304	33	118	375	2,610	287	0.24				
							36	88	120	4,608	31	115	500	3,160	316	0.78				
48/22	98	100	CL	36	19	17	27	99	126	3,312	25	124	375	4,030	186	0.19	11	1050	25	0
							26	96	121	6,624	24	119	666	5,760	231	0.49				
							28	97	124	13,248	23	119	1,200	8,820	272	0.83				

TABLE 6

CONSOLIDATED-UNDRAINED TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET) FROM	DEPTH (FEET) TO	UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	NATURAL CONDITIONS W_o %	NATURAL CONDITIONS γ_d PCF	NATURAL CONDITIONS γ_t PCF	CONSOLIDATION CONDITIONS $\bar{\sigma}_3$ PSF	CONDITIONS AFTER CONSOLIDATION W_f %	CONDITIONS AFTER CONSOLIDATION γ_{tf} PCF	CONSOLIDATED UNDRAINED STRENGTH TEST E 10^3 PSF	CONSOLIDATED UNDRAINED STRENGTH TEST $(\sigma_1-\sigma_3)^1$ PSF	CONSOLIDATED UNDRAINED STRENGTH TEST E/S_u —	SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS TOTAL STRESS ϕ deg.	SHEAR STRENGTH PARAMETERS TOTAL STRESS C PSF	SHEAR STRENGTH PARAMETERS EFFECTIVE STRESS ϕ' deg.	SHEAR STRENGTH PARAMETERS EFFECTIVE STRESS C' PSF
49/6	43	45	CL-CH	53	22	31	44	78	112	1,872	42	111	158	1,840	172	0.46	9	500	22	200
							46	75	110	3,744	45	109	333	2,710	246	0.70				
							45	77	112	7,488	39	107	583	3,860	311	1.10				
49/13	113.0	115.0	CL	33	22	11	24	100	124	3,816	23	123	400	3,570	223	0.43	10	900	25	0
							29	95	123	7,632	27	121	666	4,850	274	0.87				
							29	93	120	15,264	24	115	857	8,260	207	1.16				
50/6	28.0	30.0	CL	39	18	21	33	88	117	1,440	32	116	250	1,680	296	0.32	11	450	26	100
							33	90	120	2,880	27	114	300	2,100	285	0.74				
							34	86	115	5,760	29	111	500	3,440	291	1.06				
50/18	88.0	90.0	CL	39	23	16	28	97	124	3,456	26	122	214	3,850	111	0.27	10	900	25	200
							28	97	124	6,912	26	122	461	5,180	178	0.69				
							28	96	123	13,824	23	118	461	7,980	115	1.01				
54/4	53.0	55.0	CL	31	18	13	23	102	125	4,320	21	123	500	4,040	247	0.42	15	450	26	0
							23	102	125	8,640	20	122	461	7,730	119	0.50				
							23	101	124	2,160	22	123	285	2,860	199	0.11				
							24	100	124	6,480	20	120	666	5,610	237	0.55				
52/6	48.0	50.5	ML	--	--	--	21	101	122	2,160	22	123	533	30,320	35	0.29	42	4,000	36	0
							23	99	122	4,320	22	121	1,000	35,020	57	0.24				
							22	104	127	8,640	22	127	1,000	55,550	36	0.18				
54/6	63.0	65.0	CL	36	18	18	26	98	123	2,448	26	123	166	2,730	122	0.30	11	700	25	150
							25	98	123	4,896	23	120	562	4,010	280	0.61				
							26	98	123	9,792	22	119	900	5,860	307	1.00				
60/2	8.0	10.0	CH	53	26	27	30	94	118	590	32	124	157	1,060	298	0.01	18	260	22	170
							29	95	123	1,152	31	124	273	1,750	301	0.09				
							29	96	124	2,304	30	125	375	2,670	280	0.16				

TABLE 6

CONSOLIDATED-UNDRAINED TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET) FROM	DEPTH (FEET) TO	UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS LL	PL	PI	NATURAL CONDITIONS W_o %	γ_d PCF	γ_t PCF	CONSOLIDATION CONDITIONS $\bar{\sigma}_3$ PSF	CONDITIONS AFTER CONSOLIDATION W_f %	γ_{tf} PCF	CONSOLIDATED UNDRAINED STRENGTH TEST E 10^3 PSF	$(\sigma_1-\sigma_3)^1$ PSF	E/S_u	SKEMPTON'S $\underline{A}$ PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS TOTAL STRESS ϕ deg.	C PSF	EFFECTIVE STRESS ϕ' deg.	C' PSF
Remolded 60/2	8.0	10.0	CH	53	26	27	29	96	124	560	29	124	100	1,750	114	-0.18	19	450	27	125
							29	99	128	1,152	26	125	187	2,490	150	0.10				
							29	98	126	2,304	26	123	214	3,500	122	-0.04				
60/4	21.0	23.0	CL	43	17	26	30	94	122	1,296	31	123	102	2,780	73	-0.09	13	800	24	250
							31	94	123	5,184	30	122	900	5,130	350	0.37				
							31	95	124	2,016	30	123	281	3,180	177	0.07				
60/9	45.0	47.0	CL	38	16	22	27	99	126	2,016	26	125	500	2,530	394	0.24	10	600	25	100
							27	98	124	4,032	26	123	321	2,990	214	0.72				
							26	102	129	8,064	23	125	750	5,020	298	0.97				
60/13	67.0	69.0	CL-ML	40	19	21	24	103	128	2,520	22	126	180	3,890	93	0.12	13	1,000	25	0
							32	91	120	5,040	28	116	462	3,445	268	0.70				
							20	104	125	10,080	18	123	923	8,120	227	0.56				
							16	114	132	5,760	15	131	923	9,225	200	0.13				
							21	104	126	8,640	19	124	545	6,357	171	0.72				
105/2	9.0	11.0	CL	46	24	22	26	99	125	1,152	28	127	113	2,453	92	-0.05	27	150	25	250
							27	96	122	2,304	28	123	389	4,381	177	-0.05				
							28	98	125	864	29	126	250	2,377	210	-0.02				
105/5	40.0	42.5	CL	44	21	23	36	84	114	1,800	35	113	196	2,136	183	0.29	8	700	23	0
							36	85	116	3,600	34	114	450	2,753	327	0.56				
							35	85	115	7,200	31	111	900	3,660	491	1.13				
							39	84	117	7,200	33	112	643	3,803	169	1.12				
119/2	8.0	10.0	CL-CH	53	26	27	28	95	122	576	29	122	245	1,773	138	0.00	22	375	26	290
							28	99	127	2,304	28	127	450	4,024	223	0.09				
							29	94	121	1,440	30	122	245	2,481	99	0.17				

TABLE 6

CONSOLIDATED-UNDRAINED TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS			
																	TOTAL STRESS		EFFECTIVE STRESS	
							W_o	γ_d	γ_t	$\bar{\sigma}_3$	W_f	γ_{tf}	E	$(\sigma_1-\sigma_3)^1$	E/S_u		ϕ	C	ϕ'	C'
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	%	PCF	10^3 PSF	PSF	——		deg.	PSF	deg.	PSF
119/4	30.0	32.0	CL	41	22	19	37	86	118	1,512	35	116	333	1,970	333	0.24	8	700	26	50
							39	85	118	3,024	36	116	500	2,460	406	0.57				
							35	87	117	6,048	30	113	375	3,310	226	1.20				
129/5	18.0	21.0	CL-CH	48	21	27	34	90	121	1,152	33	120	136	2,200	123	-0.03	14	450	24	0
							32	90	119	4,608	--	--	346	4,170	165	0.42				
							33	90	120	2,304	32	119	750	2,550	588	0.26				
129/19	93.0	95.5	CL	41	21	20	24	99	123	3,240	22	121	187	3,035	123	0.45	13	500	26	0
							26	99	125	6,480	23	122	500	6,090	164	0.44				
							27	99	126	12,960	22	121	750	8,900	168	0.81				
141/4	18.0	20.0	CL	45	21	24	36	86	117	1,152	36	117	180	2,079	173	0.15	9	750	21	350
							36	87	118	2,304	35	117	818	2,780	587	0.29				
							*35 / 37	85 / 84	115 / 115	4,608 / 4,637	31 / 34	111 / 113	529 / 529	3,249 / 3,251	326 / 325	0.73 / 0.79				
158/4	17.5	20.0	CL	46	19	25	38	83	114	1,080	37	114	600	1,569	765	0.17	8	550	21	200
							34	87	117	2,160	32	115	214	1,942	220	0.51				
							37	83	114	4,320	33	110	428	2,593	330	0.95				
101,105 127,128 180,183 Combined Samples	2.0	10.0	CL-CH	--	--	--	15	113	130	1,008	21	137	150	4,261	70	-0.38	34	500	24	250
							16	114	132	2,016	19	136	210	7,531	56	-0.43				
							16	114	132	3,168	18	134	276	10,123	54	-0.39				

NOTES:
[1]At peak stress or at 15% strain, whichever is smaller.
* Two tests run on same sample. Second test run after rebounding first sample to original consolidation pressure.

TABLE 7

CONSOLIDATION TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN				SPECIFIC GRAVITY	ATTERBERG LIMITS			NATURAL CONDITIONS				P_c	C_c	C_r	SETTLEMENT PARAMETERS		REMARKS
	FROM	TO		40	100	200	2μ		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	e_o —	10^3 PSF	—	—	$\frac{C_c}{1+e_o}$	$\frac{C_r}{1+e_o}$	
27/10	34.0	34.5	CL					2.73	41	22	19	39	84	117	1.02	3.4	0.44	0.10	0.22	0.05	
27/24	104.2	104.5	CL					2.74	43	25	18	34	90	121	0.91	8.0	0.31	0.10	0.16	0.05	Silty Clay, Sandy
38/4*	14.6	14.7	CL-CH	-	-	98	60	2.71	46	22	24	29	96	124	0.77	10.0	0.19	0.06	0.11	0.03	
38/16	74.0	74.1	CH	-	-	98	60	2.72	55	24	31	36	87	118	0.94	9.4	0.38	0.06	0.20	0.03	
41/5*	10.8	11.0	CL-CH	-	-	98	57	2.72	46	23	23	30	94	122	0.80	11.9	0.23	0.08	0.13	0.04	
41/7	21.0	21.1	CL-CH					2.70	47	24	23	38	82	113	1.06	2.5	0.34	0.09	0.17	0.04	
41/13	53.0	53.2	CL-CH					2.75	52	25	27	47	77	113	1.24	3.5	0.35	0.10	0.16	0.04	
41/17	73.3	73.5	CL	85	74	65	24	2.68	25	15	10	27	98	124	0.70	5.3	0.21	0.05	0.12	0.03	Silty Clay, Sandy
41/25*	113.0	113.2	CL					2.71	29	19	10	24	103	128	0.64	9.4	0.18	0.05	0.11	0.03	Silty Clay, Sandy
41/29*	130.9	131.1	GC-SC					2.69	25	17	8	11	123	137	0.37	10.0	0.10	0.04	0.07	0.03	Clayey Sand, Gravelly
48/10	39.2	39.4	CL-CH					2.73	47	24	23	39	84	117	1.03	4.0	0.33	0.09	0.16	0.04	
49/3	13.7	14.0	CL-CH					2.72	47	23	24	33	91	121	0.86	6.4	0.26	0.07	0.14	0.04	
49/11*	93.8	94.0	CL					2.68	37	22	15	29	98	126	0.70	5.6	0.20	0.05	0.12	0.03	
50/8	38.5	38.9	CH					2.75	55	23	32	52	72	109	1.38	4.0	0.55	0.12	0.23	0.05	
52/4	29.9	30.2	CL-CH					2.70	49	20	29	41	84	118	1.01	4.4	0.45	0.09	0.22	0.04	
53/5	39.5	39.8	CL	85	76	66	30	2.72	39	20	19	31	91	119	0.87	6.5	0.30	0.09	0.16	0.05	Silty Clay, Sandy
54/6*	63.5	63.8	CL	89	83	77	33	2.71	36	18	18	26	99	125	0.70	6.2	0.24	0.07	0.14	0.04	Silty Clay, Sandy
54/8	73.7	74.0	CL	96	94	92	46	2.73	45	21	24	39	86	120	0.98	5.6	0.41	0.08	0.21	0.04	
60/2*	9.8	10.0	CL-CH	-	-	-	60	2.71	53	26	27	30	94	122	0.79	9.2	0.23	0.07	0.13	0.04	
60/16*	85.2	85.4	CL	83	80	78	34	2.73	40	19	21	28	98	125	0.74	9.0	0.27	0.07	0.16	0.04	
105/1*	5.1	5.4	CH					2.72	53	24	29	24	103	128	0.64	4.0	0.10	0.05	0.06	0.03	
105/8	70.9	71.2	CL					2.70	37	19	18	24	103	128	0.63	7.2	0.21	0.06	0.13	0.04	Sheet 1 of 2
118/5	38.6	38.9	CL					2.70	41	22	19	37	86	118	0.97	4.6	0.39	0.10	0.20	0.05	* INDICATES SAMPLES
118/9*	78.7	79.0	CL					2.70	42	23	19	28	97	124	0.74	8.6	0.24	0.06	0.14	0.03	BELIEVED TO BE
																					RELATIVELY DISTURBED.

TABLE 7
CONSOLIDATION TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET) FROM	DEPTH (FEET) TO	UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN 40	100	200	2μ	SPECIFIC GRAVITY	ATTERBERG LIMITS LL	PL	PI	NATURAL CONDITIONS W_o %	γ_d PCF	γ_t PCF	e_o	P_c 10^3 PSF	C_c	C_r	SETTLEMENT PARAMETERS $\frac{C_c}{1+e_o}$	$\frac{C_r}{1+e_o}$	REMARKS
129/9	39.1	39.3	CL					2.73	41	22	19	40	82	115	1.08	2.9	0.39	0.09	0.19	0.04	
129/21	103.7	104.0	CL					2.71	39	21	18	28	99	127	0.70	6.4	0.23	0.06	0.14	0.04	Silty Clay, Sandy
142/6	20.1	20.5	CL					2.70	45	22	23	38	83	115	1.02	4.6	0.43	0.05	0.21	0.02	
185/3*	7.9	8.1	CL-CH					2.72	50	23	27	29	96	124	0.76	8.0	0.18	0.04	0.10	0.02	

Sheet 2 of 2

* INDICATES SAMPLES BELIEVED TO BE RELATIVELY DISTURBED.

TABLE 8

CONSOLIDATION TEST RESULTS

REMOLDED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	SPECIFIC GRAVITY	ATTERBERG LIMITS			PRETEST CONDITIONS				P_c	C_c	C_r	SETTLEMENT PARAMETERS		REMARKS
	FROM	TO			LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	e_o —	10^3 PSF	—	—	$\frac{C_c}{1+e_o}$	$\frac{C_r}{1+e_o}$	
136/6	13.0	14.6	CL	2.74	43	22	21	17	102	119	0.68	2.5	0.18	0.05	0.11	0.03	
146/7	14.0	16.1	CL	2.75	46	22	24	16	102	118	0.68	3.3	0.15	0.06	0.09	0.04	

TABLE 9

PERMEABILITY TEST RESULTS

UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS % FINER THAN					SPECIFIC GRAVITY	ATTERBERG LIMITS			PRETEST CONDITIONS				CONSOLIDATION PRESSURE	VOID RATIO, e, AFTER CONSOLIDATION	PERMEABILITY
	FROM	TO		4	40	100	200	2μ		LL	PL	PI	W_o %	γ_d PCF	γ_t PCF	e_o —	kg/cm^2		10^{-8}cm/sec.
50/6	28.3	28.5	CL	--	--	--	97	53	2.70	39	18	21	37	84	115	1.00	1.50	0.875	3.0
50/10	48.6	48.8	CL	98	92	86	82	37	2.70	36	16	20	27	97	123	0.73	2.00	0.645	2.6
52/7	58.6	58.9	CL	98	83	72	57	12	2.70	23	14	9	15	119	137	0.41	2.30	0.374	2.2
53/5	39.5	39.8	CL	96	85	77	67	30	2.72	39	20	19	30	104	135	0.73	1.74	0.685	3.5
54/6	63.5	63.8	CL	98	89	83	77	34	2.71	36	18	18	27	98	124	0.72	2.40	0.641	3.0
54/6	73.7	74.0	CL	--	96	93	91	45	2.73	45	21	24	32	90	119	0.85	2.71	0.729	2.3
60/3	18.1	18.3	CL	--	--	--	98	52	2.70	39	21	18	26	103	130	0.71	1.05	0.686	1.6
60/11	56.1	56.4	CL	95	84	79	76	34	2.70	33	18	15	27	98	124	0.73	2.20	0.575	1.8
60/16	85.6	86.1	CL	96	82	80	78	33	2.73	40	19	21	29	96	124	0.75	3.00	0.605	2.6

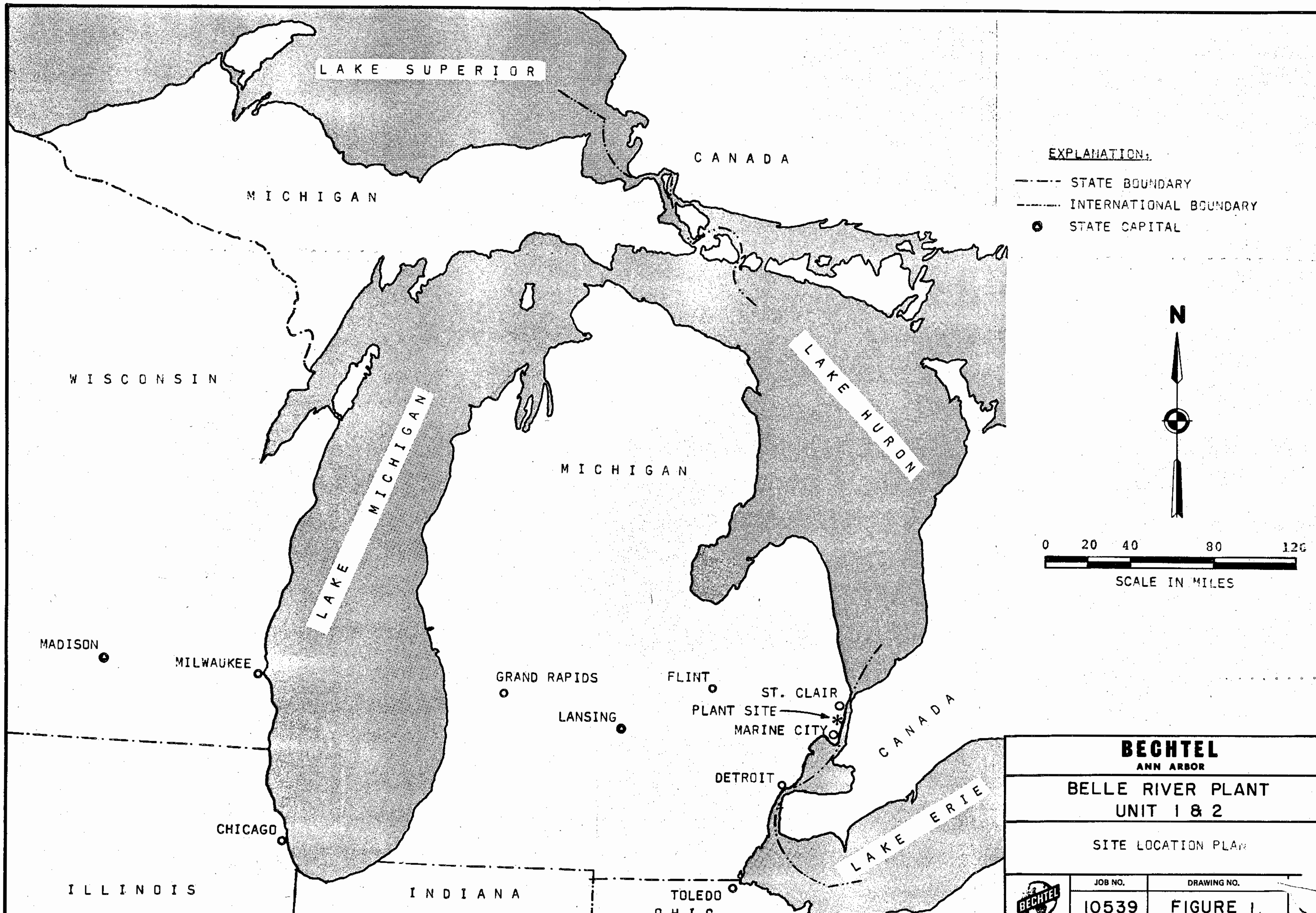
TABLE 10

RECOMMENDED DESIGN PROPERTIES FOR SITE SOILS

Static Properties	Upper Stratum[1] 0 - 20 Ft	Middle Stratum[1] 20 - 50 Ft	Lower Stratum[1] 50 + Ft
In Situ Total Density (PCF)	125	115	125
In Situ Moisture Content (%)	25	35	25
Degree of Saturation (%)	100	100	100
Specific Gravity	2.72	2.72	2.71
Poisson's Ratio[2]			
Drained	0.4	0.4	0.4
Undrained	0.5	0.5	0.5
Initial Modulus of Elasticity (KSF)	700	330	350
Maximum Dry Density per ASTM 1557	118-112[3]	-	-
Optimum Moisture Content	13-16[3]	-	-
Permeability (cm/sec x 10^{-8})	2	2	2
Unconfined Compression Shear Strength			
Cohesion (PSF)	550	550	850
Consolidated Undrained Shear Strength			
Effective Stress Basis			
ϕ' (Deg.)	28	28	25
c' (PSF)	0	0	0
Total Stress Basis			
ϕ (Deg.)	13	13	10
c (PSF)	460	460	710
Settlement Parameter $C_c/1+e_o$	0.13	0.20	0.14
Coefficient of Consolidation (C_v) Ft^2/day	0.15	0.15	0.15

[1]The depths of the different strata are approximate (see text).
[2]Typical values.
[3]Refer to Figure 40 for additional information.

FIGURES

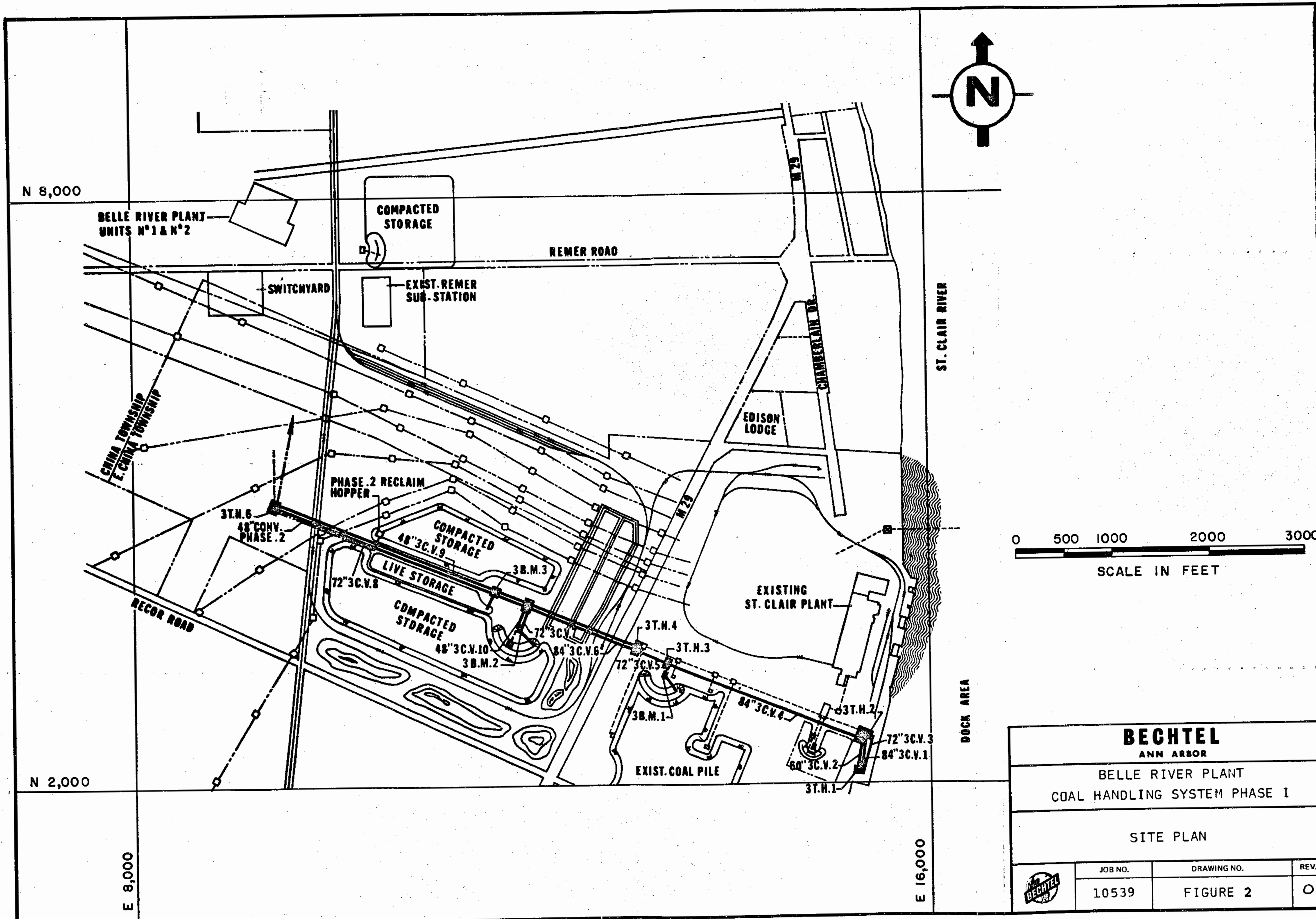


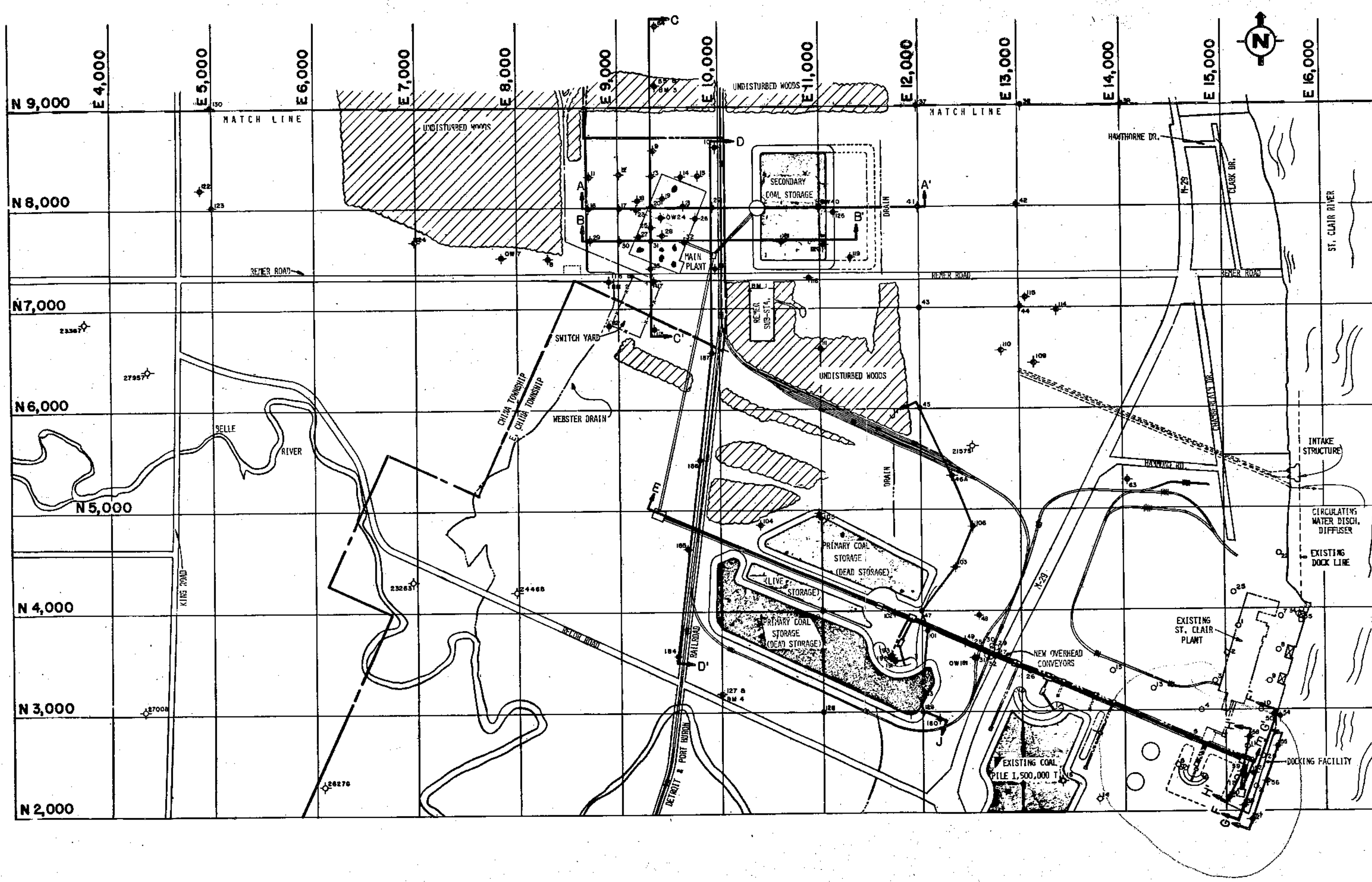
BECHTEL
ANN ARBOR

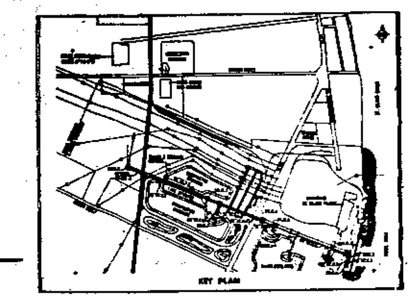
BELLE RIVER PLANT
UNIT 1 & 2

SITE LOCATION PLAN

JOB NO.	DRAWING NO.
10539	FIGURE 1


N
N 8,000
N 2,000
E 8,000
E 16,000
BELLE RIVER PLANT UNITS N°1 & N°2
COMPACTED STORAGE
REMER ROAD
SWITCHYARD
EXIST. REMER SUB. STATION
M 29
CHAMBERLAIN DR.
ST. CLAIR RIVER
EDISON LODGE
CHINA TOWNSHIP
E. CHINA TOWNSHIP
PHASE 2 RECLAIM HOPPER
3T.H.6
48"CONV. PHASE 2
48"3C.V.9
COMPACTED STORAGE
LIVE STORAGE
72"3C.V.8
3B.M.3
COMPACTED STORAGE
72"3C.V.7
48"3C.V.10
84"3C.V.6
3B.M.2
RECOR ROAD
3T.H.4
3T.H.3
72"3C.V.5
3B.M.1
84"3C.V.4
3T.H.2
72"3C.V.3
84"3C.V.1
60"3C.V.2
3T.H.1
EXIST. COAL PILE
EXISTING ST. CLAIR PLANT
DOCK AREA
0 500 1000 2000 3000
SCALE IN FEET
BECHTEL
ANN ARBOR
BELLE RIVER PLANT
COAL HANDLING SYSTEM PHASE I
SITE PLAN
JOB NO. 10539
DRAWING NO. FIGURE 2
REV. 0





NOTES:

1. FOR SUBSURFACE PROFILES SEE FIGURE 9, A THROUGH N.
2. SECTIONS A, B, AND C ARE BASED ON ORIGINAL PLANT LOCATION.
3. SEE FIGURE 4 FOR ADDITIONAL BORING LOCATIONS.

EXPLANATION

TOWNSHIP BOUNDARY

N N' SUBSURFACE PROFILE N–N'

187 BORING LOCATION

OW DENOTES OBSERVATION WELL

BM 4 BENCH MARK

35 BORING LOCATIONS FROM PREVIOUS INVESTIGATIONS FOR ST. CLAIR PLANT

26278 WELLS DRILLED FOR OIL OR GAS EXPLORATION - SHOWING PERMIT NUMBER (ALL HOLES WERE DRY)

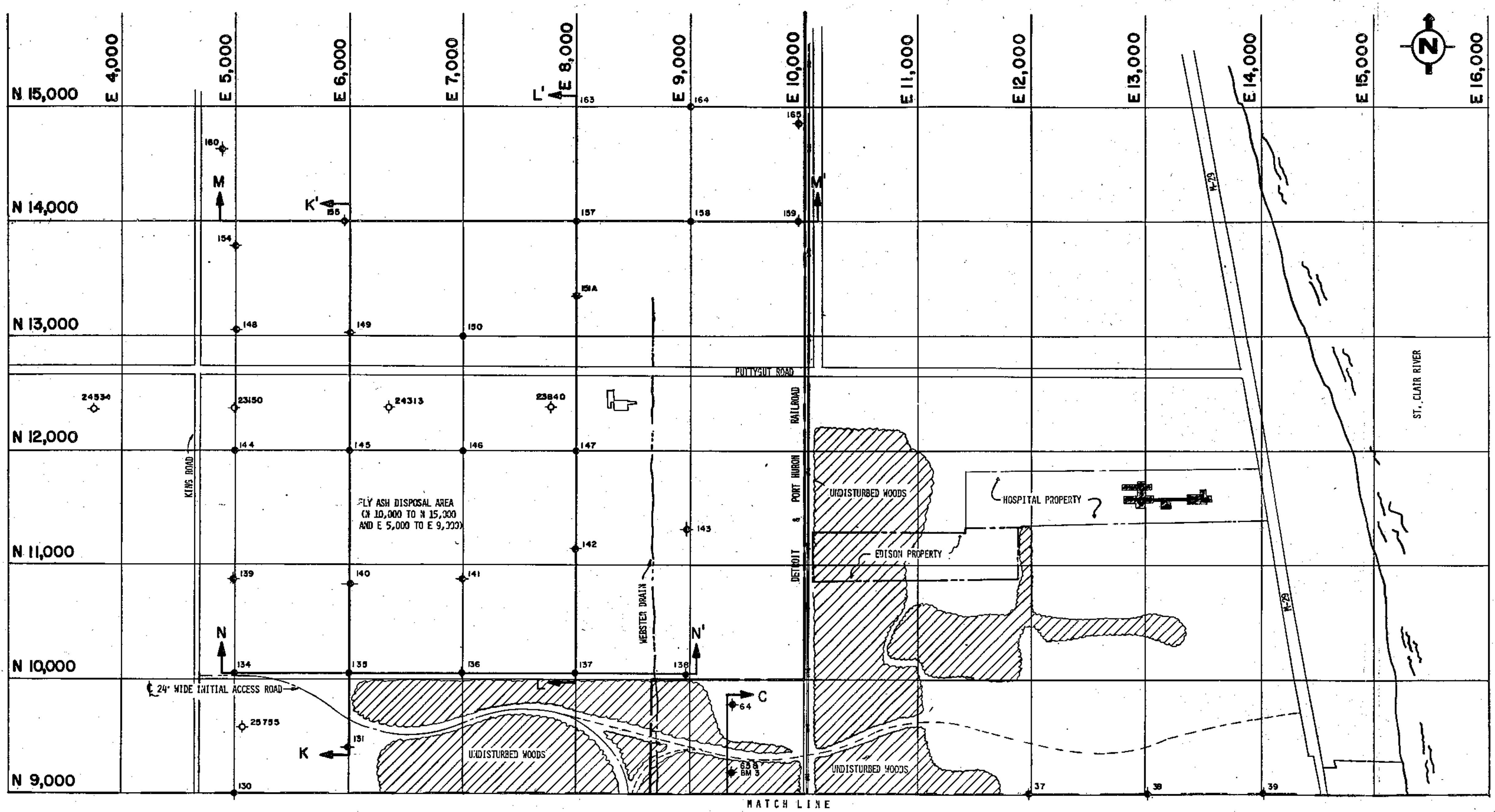
0 100 200 400 800 1200 Feet
SCALE

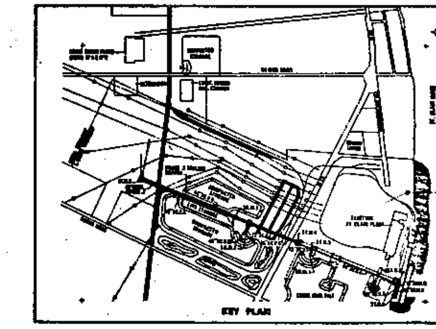
BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

BORING LOCATION PLAN
SOUTH AREA

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 3	2





NOTES:

1. FOR SUBSURFACE PROFILES, SEE FIGURE 9, A THROUGH N.
2. SEE FIGURE 3 FOR ADDITIONAL BORING LOCATIONS.

EXPLANATION

TOWNSHIP BOUNDARY

N N' SUBSURFACE PROFILE N-N'

165 BORING LOCATION FROM THIS INVESTIGATION

BM 3 BENCH MARK

25755 WELLS DRILLED FOR OIL OR GAS EXPLORATION - SHOWING PERMIT NUMBER (ALL HOLES WERE DRY)

0 400 800 1200

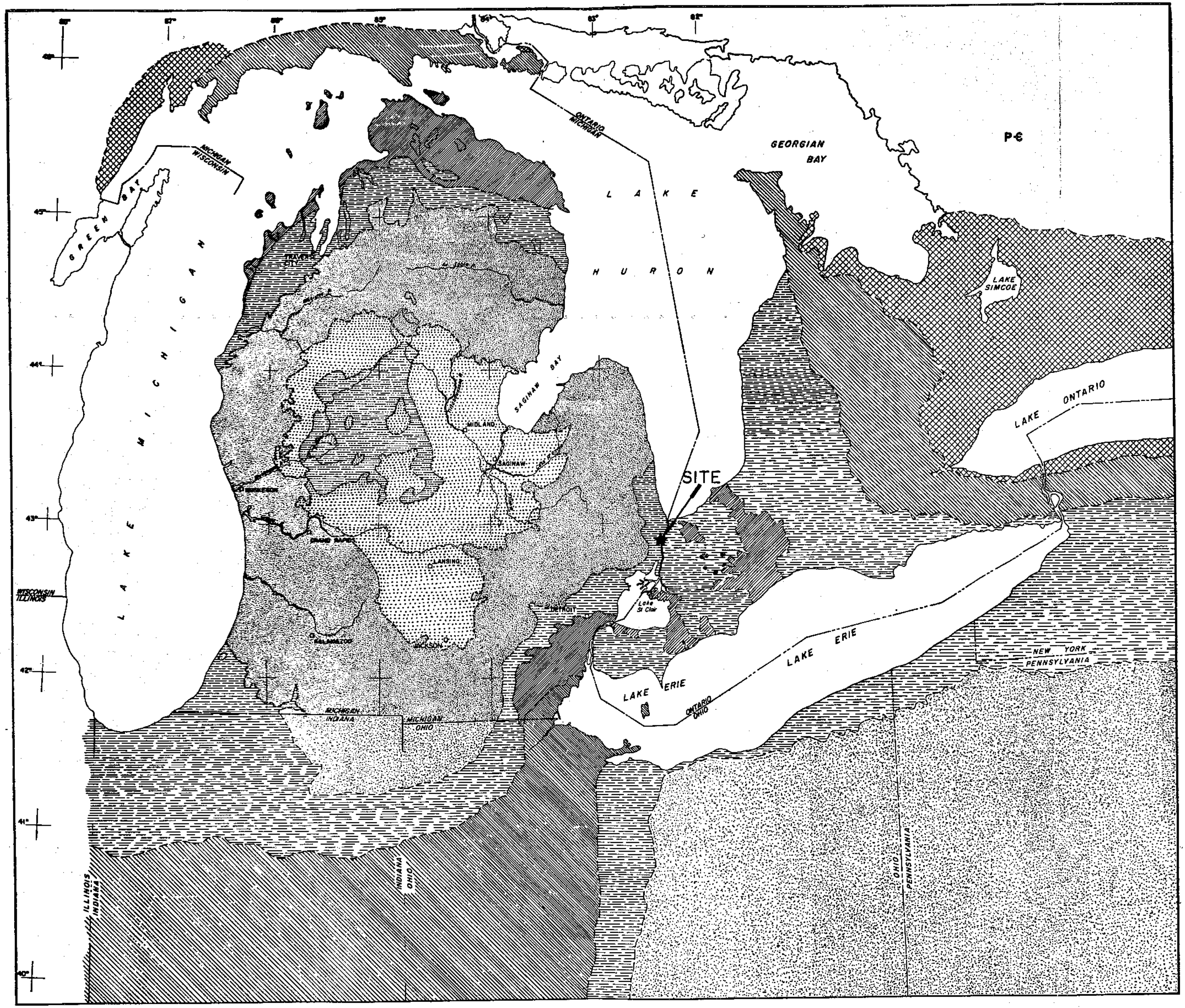
SCALE IN FEET

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

BORING LOCATION PLAN
NORTH AREA

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 4	1



EXPLANATION

Era	Period	Unit
MESOZOIC	JURASSIC	Former "Permo-Carboniferous red beds"; shale, clay and sandy shales.
PALEOZOIC	PENN-SYLVANIAN	Grand River Formation and Saginaw Formation; chiefly sandstone, some shaly limestone and coal.
	MISSISSIPPIAN	Grand Rapids Group, Marshall Sandstone and Coldwater Shale; chiefly shale and dolomitic shale, some limestone and sandstone
	MISSISSIPPIAN / DEVONIAN	Ellsworth Shale, Bedford Shale, and Antrim Shale; shale with some sandstone.
	DEVONIAN	Traverse Group and Detroit River Group; chiefly limestone and dolomite, some shale, sandstone and salt.
	SILURIAN	Bass Islands Group, Salina Group, Manistique Group, Burnt Bluff Group, and Cataract Group; dolomitic shale, dolomite and limestone, some salt.
	ORDOVICIAN	Undifferentiated; shale, siltstone, limestone and dolomite.
PRE CAMBRIAN		P€ Undifferentiated; complex sequence of metamorphosed igneous and sedimentary rocks.

N

NOTE:

Geology is generalized from the following:

(1) The Centennial Geologic Map of the Southern Peninsula of Michigan, 1936, Mich. Geol. Survey.
(2) Stratigraphic Succession in Michigan, Chart I, 1964, Mich. Geol. Survey.
(3) Bedrock of Michigan, Small Scale Map 2, 1968, Mich. Geol. Survey.
(4) Geology of Toronto — Windsor Area, 1969, Geological Survey of Canada.
(5) Geologic Map of North America, 1965, U.S. Geological Survey.

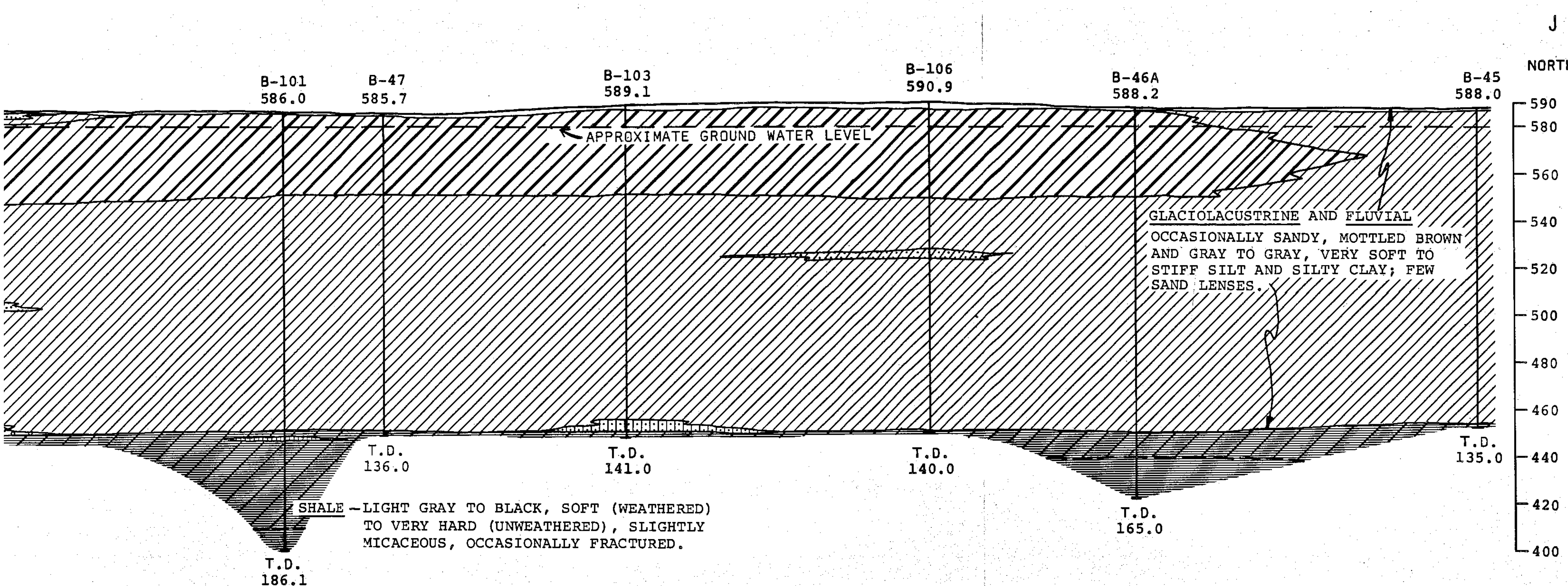
10 0 10 20 30 40 50
SCALE IN MILES

BECHTEL
SAN FRANCISCO

BELLE RIVER POWER PLANT
UNITS 1 & 2

BEDROCK GEOLOGY LOWER PENINSULA MICHIGAN

JOB No.	DRAWING No.	REV.
10539	FIGURE 5	0



ND

Clayey Sand (SC)

Silty Sand (SM)

Silt (ML)

Shale (weathered)

hale (unweathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

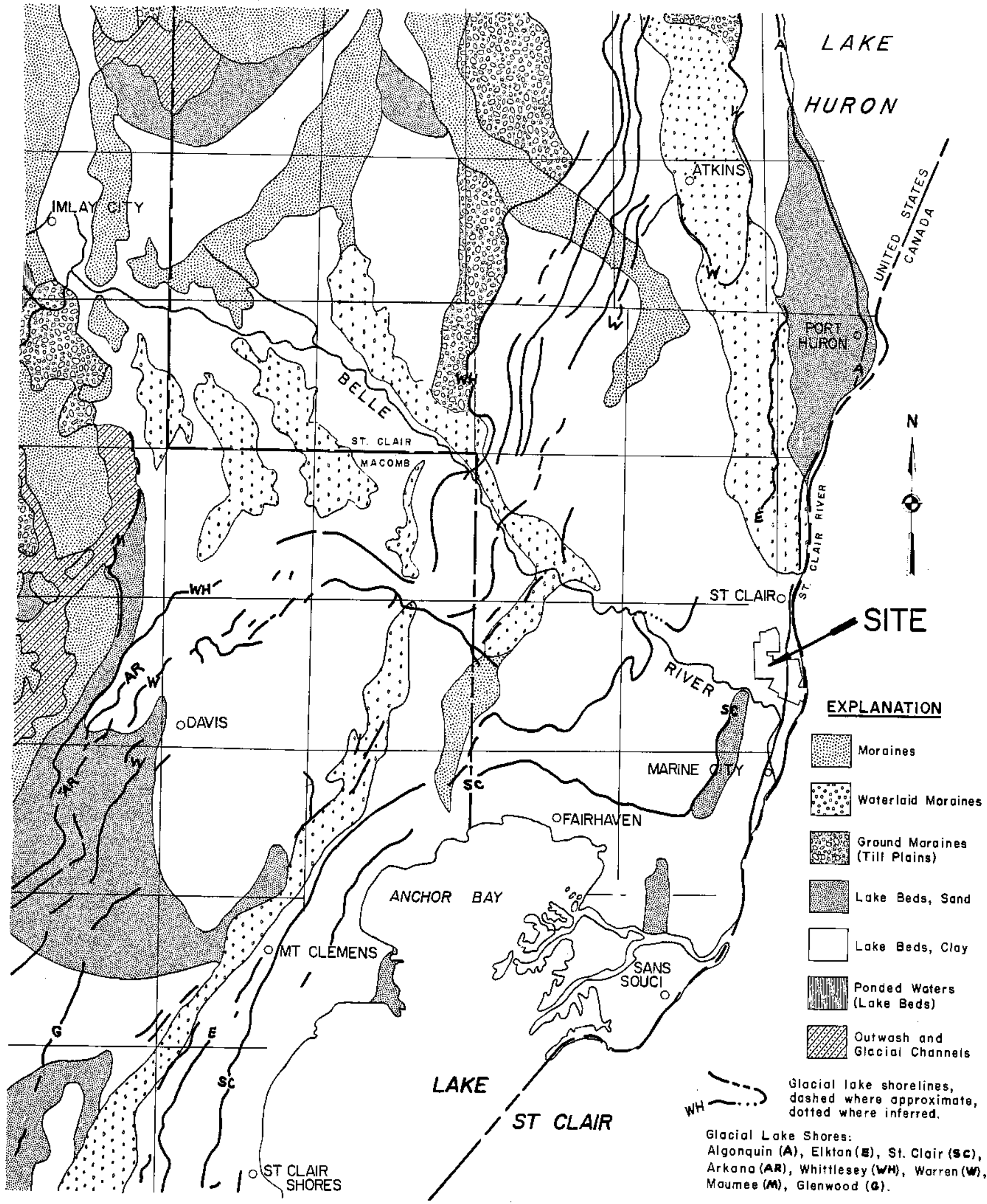
0 100 200 400 600

SCALE IN FEET

NOTES:

1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION J-J'		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



NOTE:

From Map of Surface Formations of the Southern Peninsula of Michigan, Michigan Department of Conservation, Geologic Survey Division, 1955.

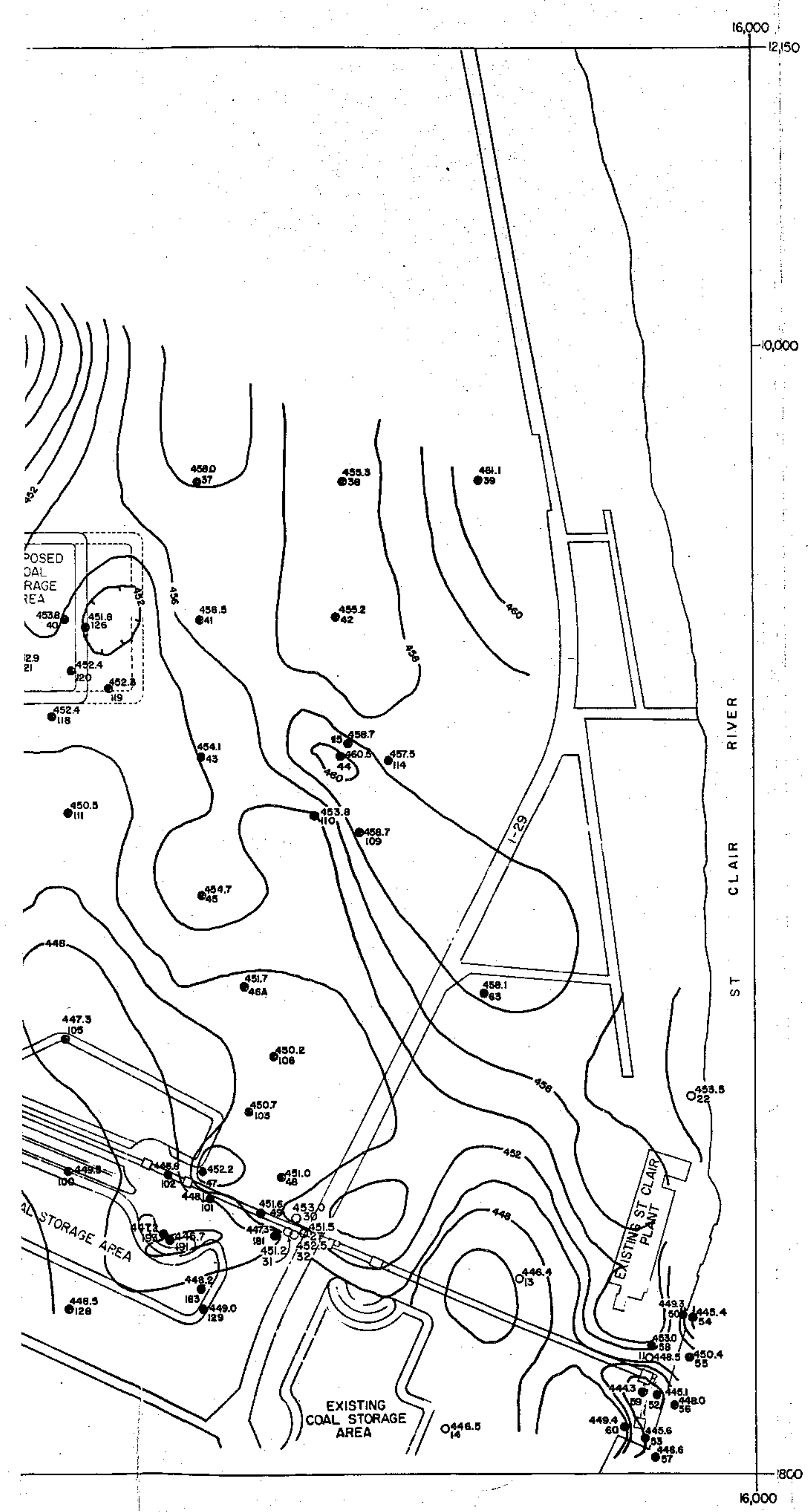
0 1 2 3 4 5
SCALE IN MILES

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SURFICIAL GEOLOGY
ST. CLAIR AND MACOMB COUNTIES

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 6	0



EXPLANATION

434.4 Top of rock elevation (ft)
120 Boring number (present investigation)

452.5 Top of rock elevation (ft)
32 Boring number (previous investigations for St Clair plant)

NOTES:

1. Contours generated from drill hole data by McDonnell Douglas Automation Company's SURMAP computer program.
2. Computer interpretation modified manually to accommodate additional data points.
3. Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.

0 200 400 800 1200
SCALE IN FEET

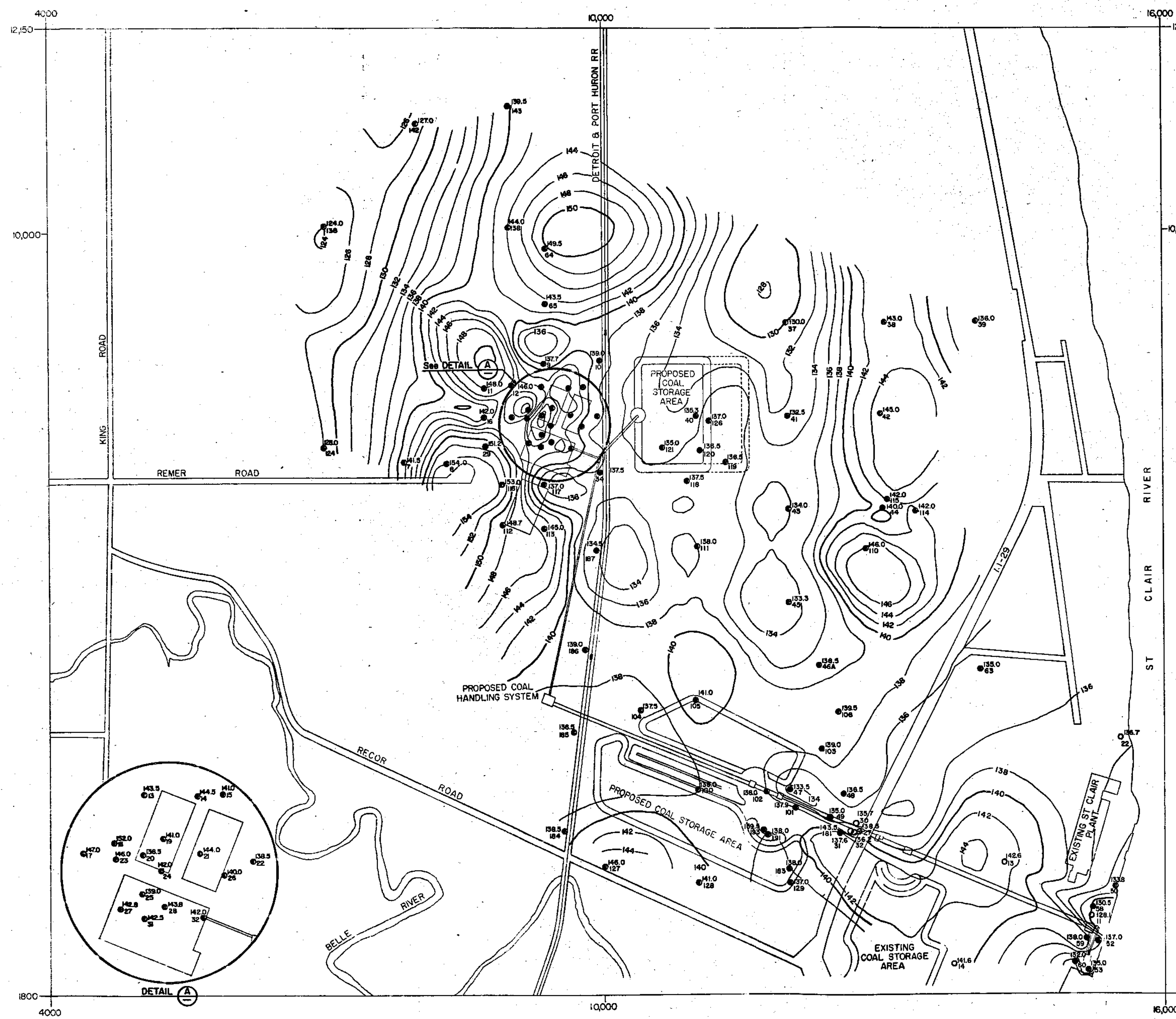
CONTOUR INTERVAL = 2 FT

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

TOP OF ROCK CONTOUR MAP

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 7	1



EXPLANATION

134.5 — Overburden thickness (ft)
187 — Boring number (present investigation)

136.2 — Overburden thickness (ft)
32 — Boring number (previous investigations for St. Clair plant)

—150— Line through points of equal thickness of overburden in feet

NOTES:

1. Thickness contours generated from drill hole data by McDonnell Douglas Automation Company's SURMAP computer program.
2. Computer interpretation modified manually to accommodate additional data points.
3. Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.

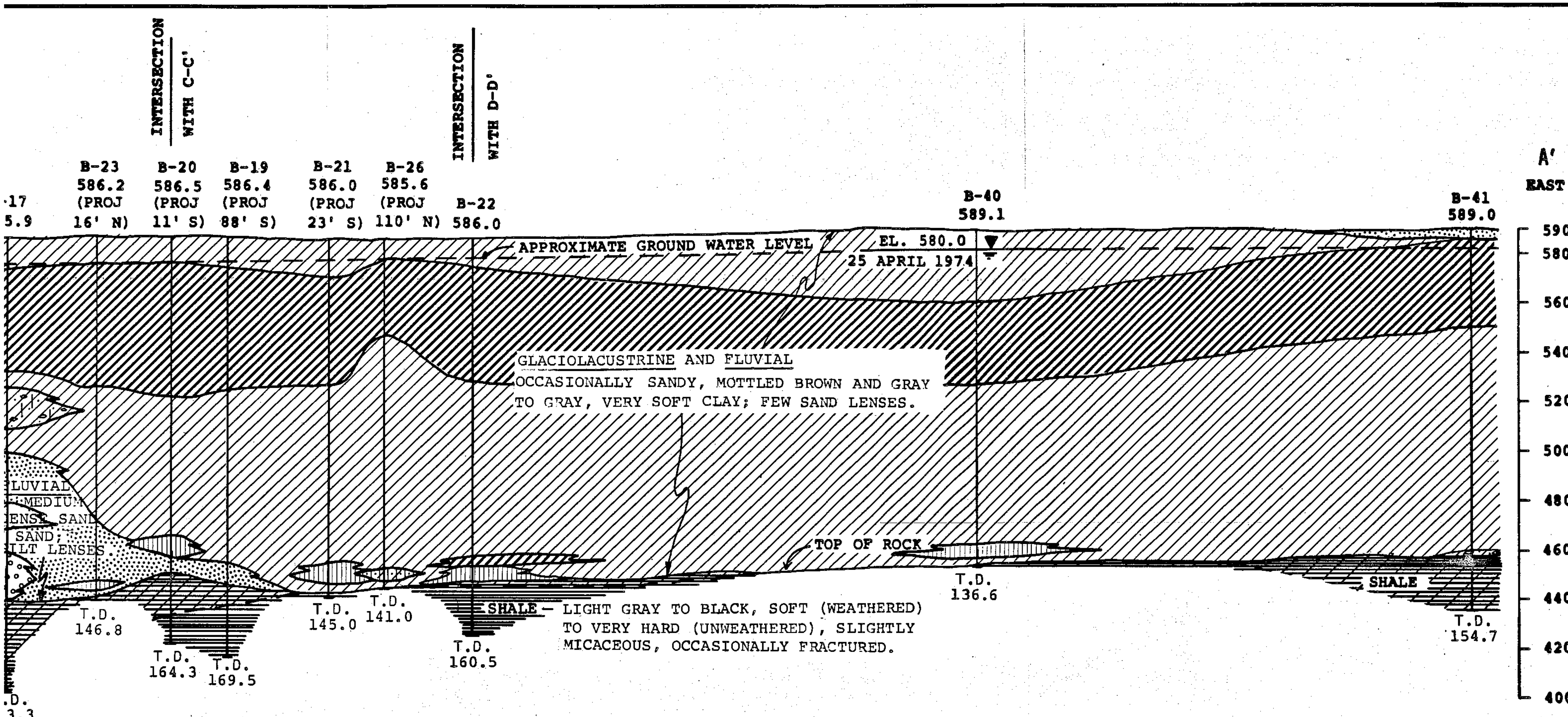
N

0 200 400 800 1200

SCALE IN FEET

THICKNESS INTERVAL = 2 FT

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
OVERBURDEN THICKNESS CONTOUR MAP		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 8	1



PLANT AREA – PRECIPITATORS AND COAL STORAGE AREA

.EGEND

.)		Clayey Sand (SC)
1)		Silty Sand (SM)
›)		Gravel (GM)
W)		Shale (weathered)
)		Shale (unweathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

0 100 200 400 600

SCALE IN FEET

NOTES:

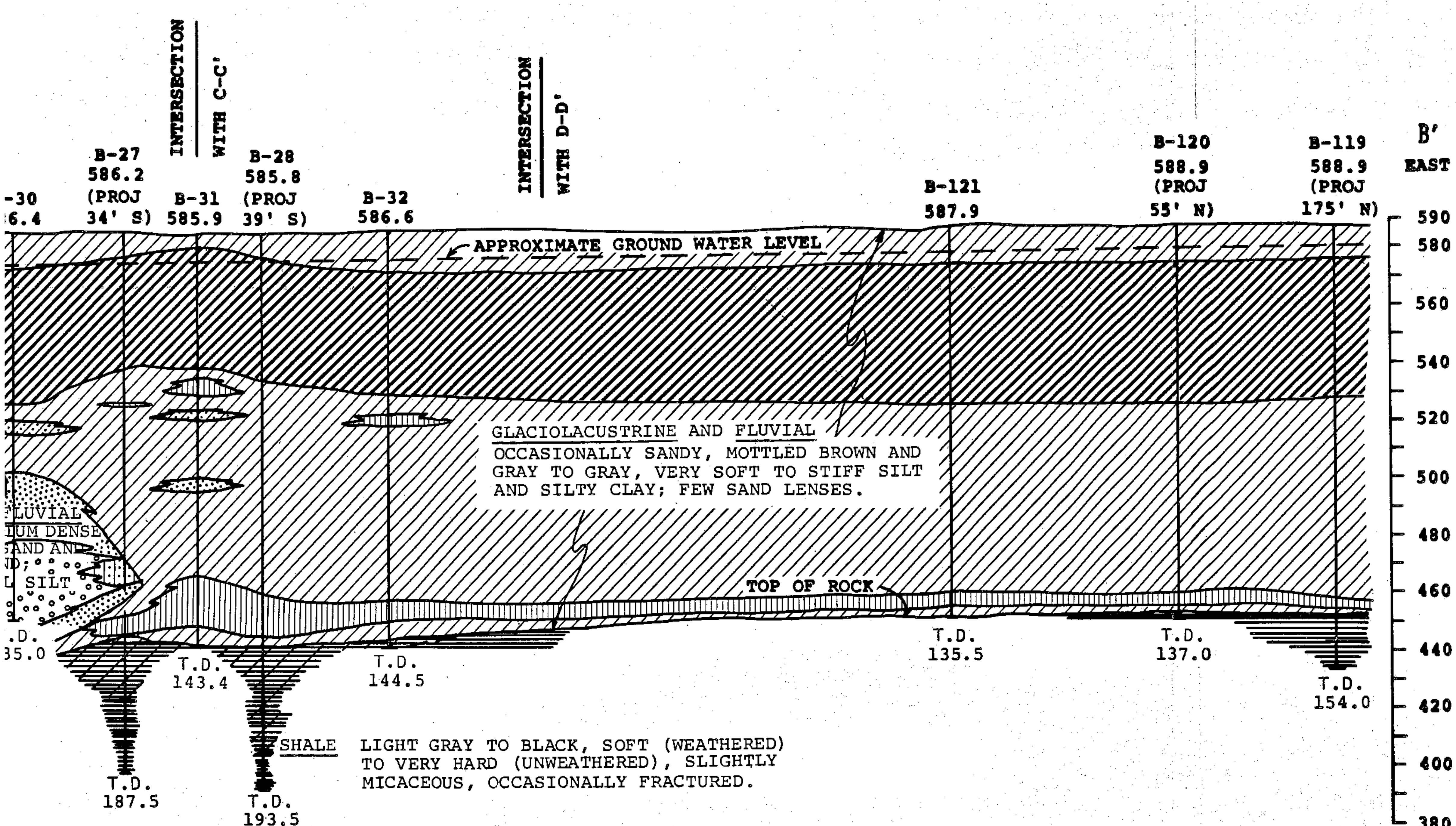
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION A-A'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	O



EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

0 100 200 400 600

SCALE IN FEET

PLANT AREA — UNITS 1 & 2 COAL STORAGE AREA

LEGEND

Sand (SW)	Silty Sand (SM)
Silt (ML)	Shale (weathered)
Clayey Sand (SC)	Shale (unweathered)

NOTES:

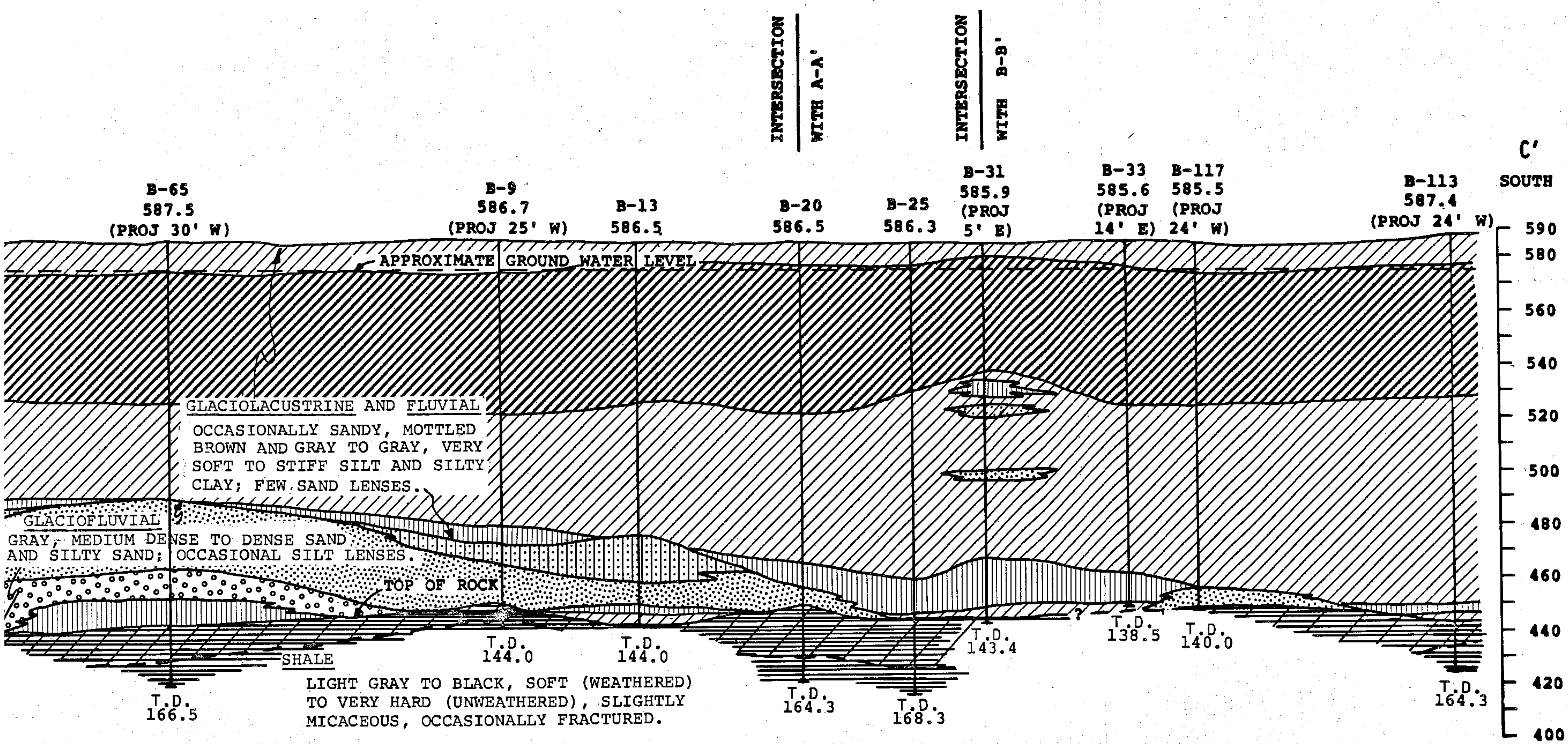
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION B-B'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	O



PLANT AREA – UNIT I AND SWITCHYARD

Silt (ML)

Clayey Sand (SC)

Silty Sand (SM)

Shale (weathered)

Shale (unweathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

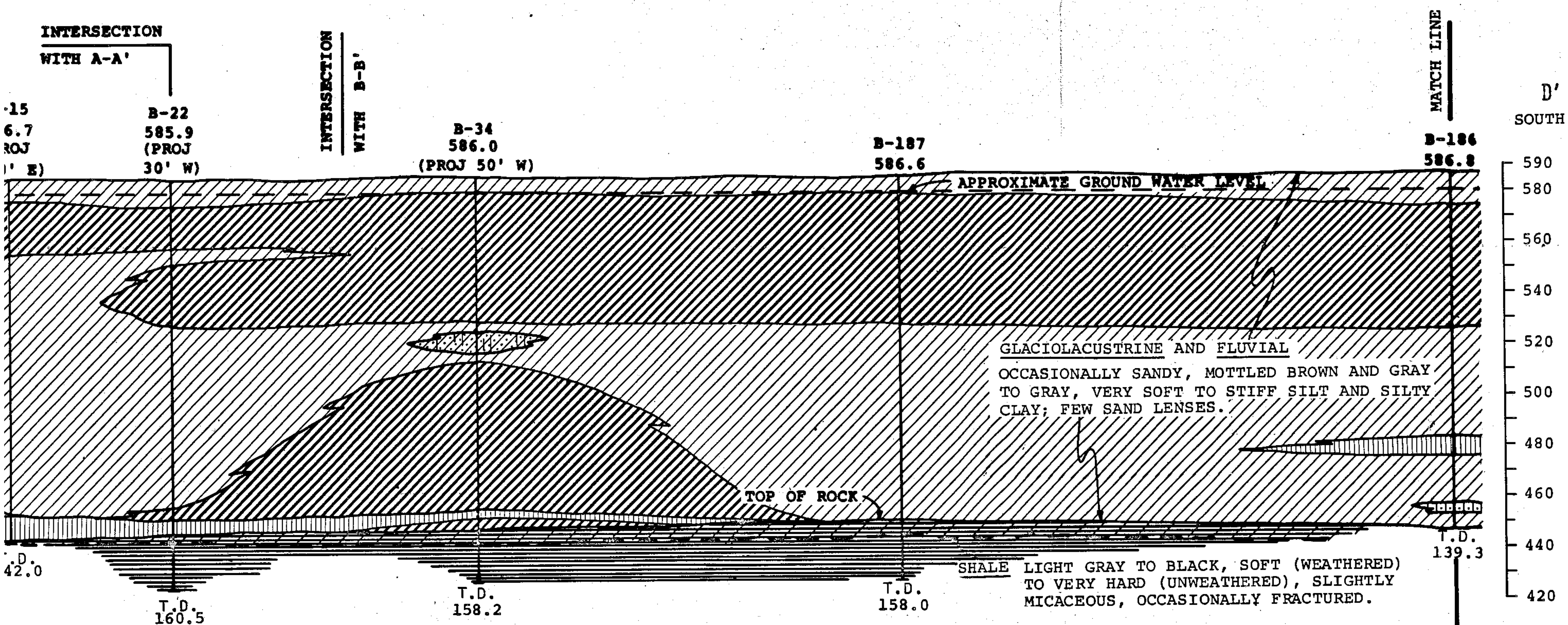
0 100 200 400 600

SCALE IN FEET

NOTES:

1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.3.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION C-C'		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



PLANT AREA AND COAL HANDLING CONVEYOR SYSTEM

Shale (weathered)

Shale (unweathered)

(SC)

(SM)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

0 100 200 400 600

SCALE IN FEET

NOTES:

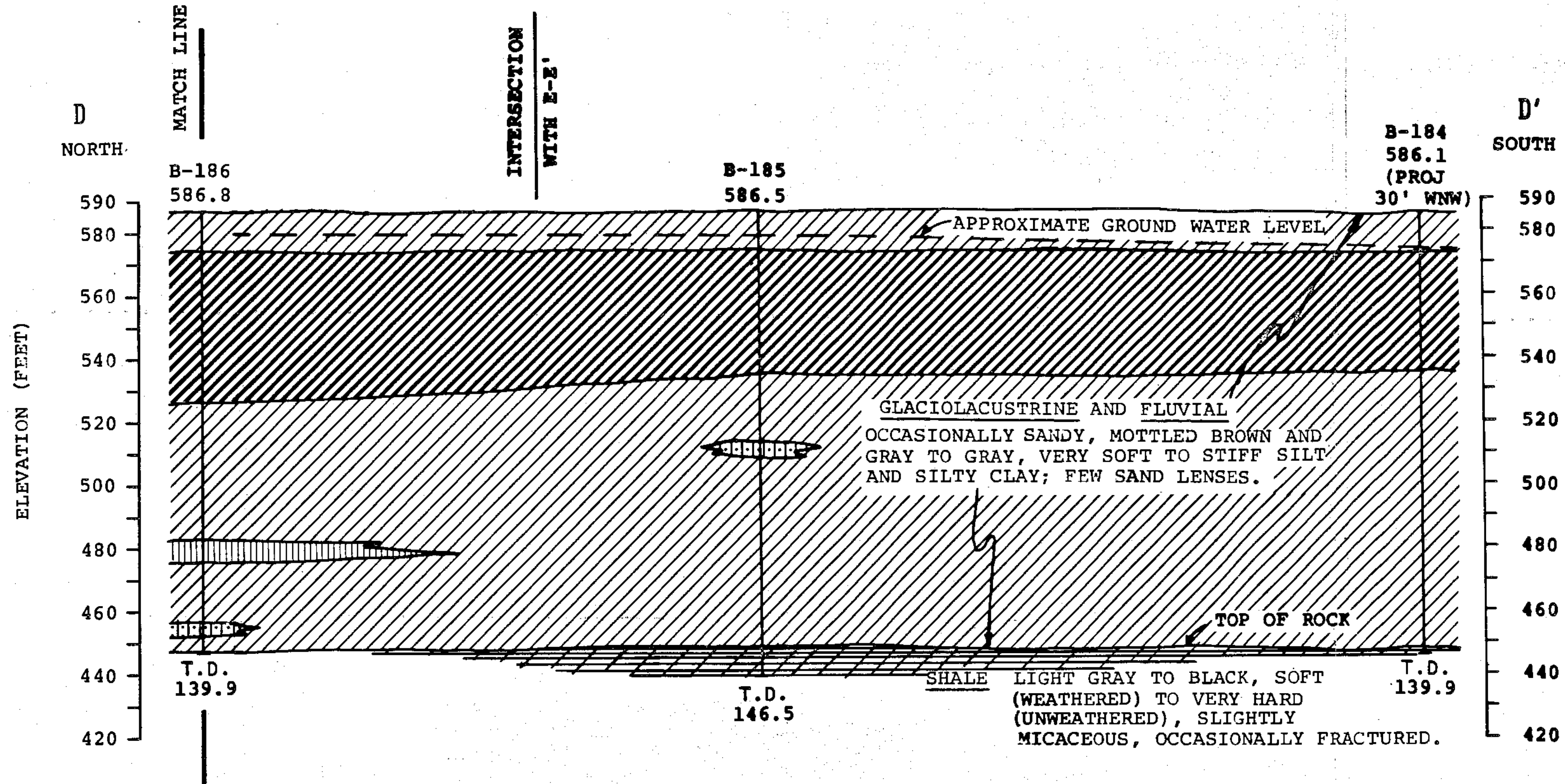
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION D-D'
SHEET 1 OF 2

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



PLANT AREA AND COAL HANDLING CONVEYOR SYSTEM

LEGEND

- Clay (CL)
- Clay (CH)
- Silt (ML)
- Silty Sand (SM)
- Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

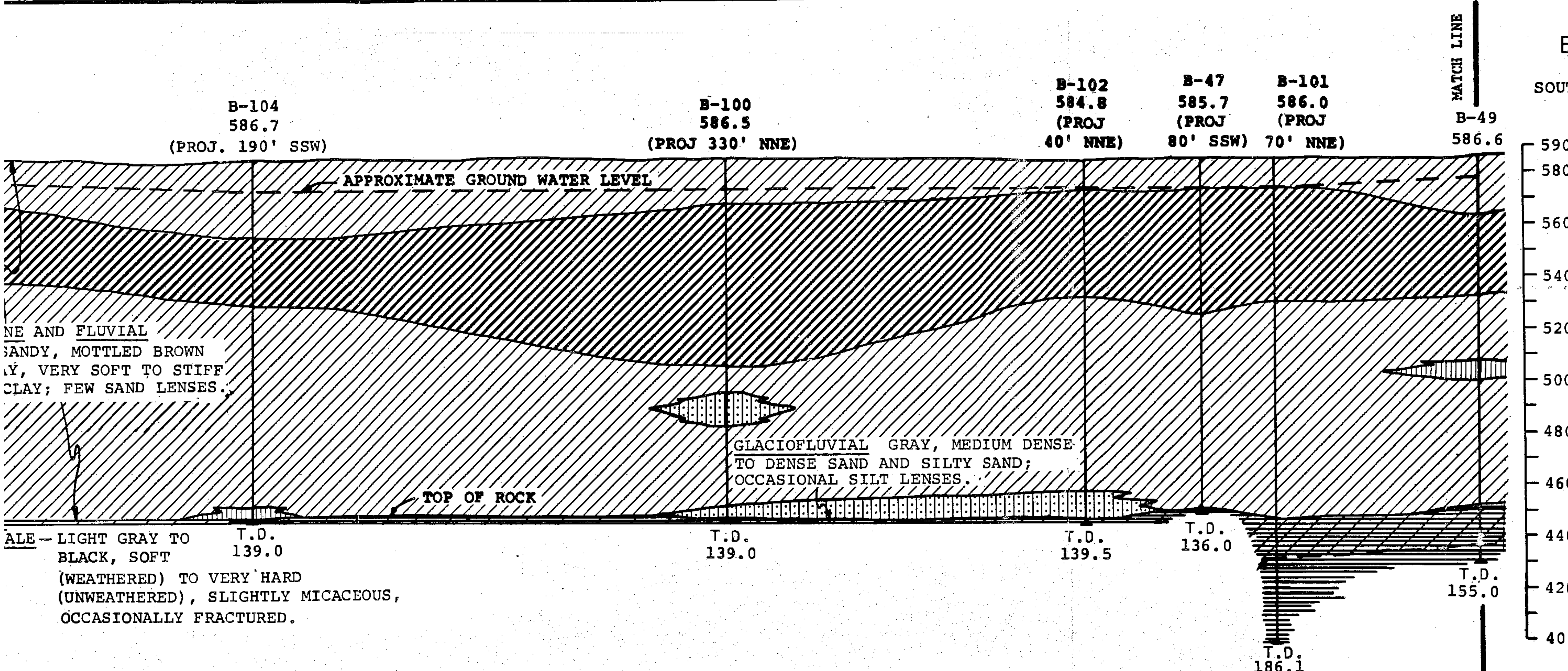
0 100 200 400 600

SCALE IN FEET

NOTES:

1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION D-D' SHEET 2 OF 2		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



COAL HANDLING CONVEYOR SYSTEM AND COAL STORAGE AREAS

EXPLANATION

B-187 Bechtel borings (1973 - 1974)

T.D. Total depth drilled (ft)

I (SM)

thered)

eathered)

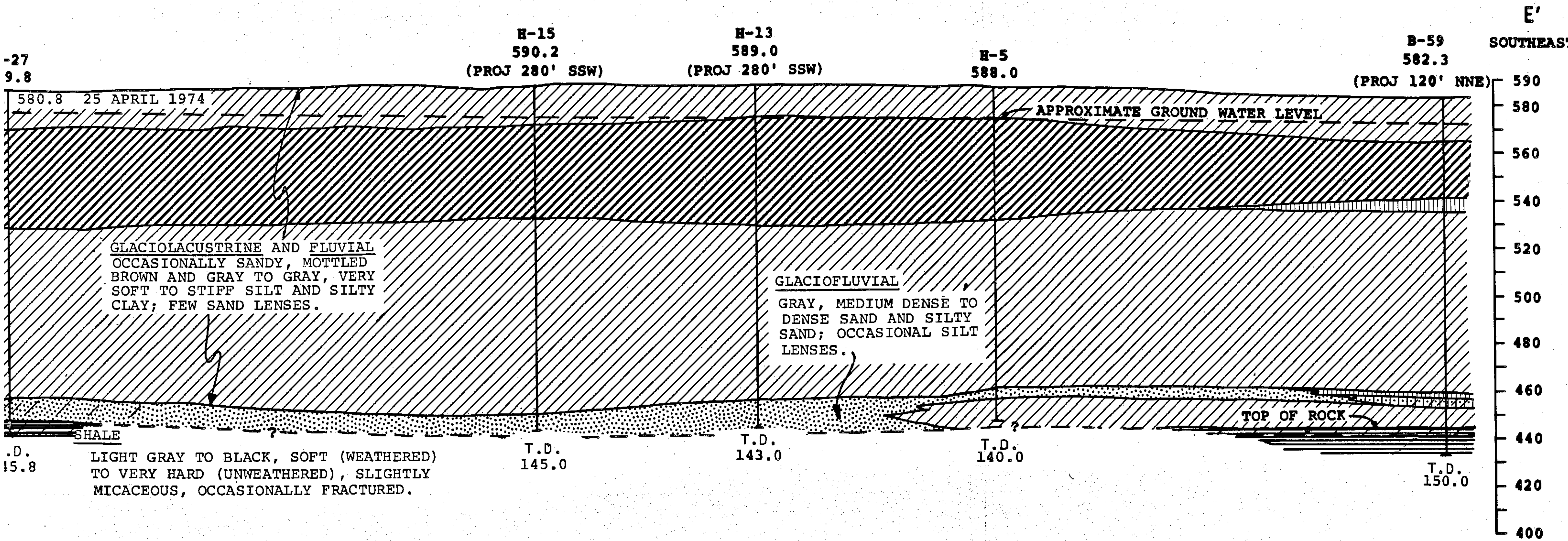
0 100 200 400 600

SCALE IN FEET

NOTES:

1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION E-E' SHEET 1 OF 2		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	O



COAL HANDLING CONVEYOR SYSTEM AND COAL STORAGE AREAS

END

- Clayey Sand (SC)
- Silty Sand (SM)
- Shale (weathered)
- Shale (unweathered)

EXPLANATION

B-187	Bechtel borings (1973-1974)
H-15	Housel borings (1950-1967)
T.D.	Total depth drilled (ft)

0 100 200 400 600

SCALE IN FEET

NOTES:

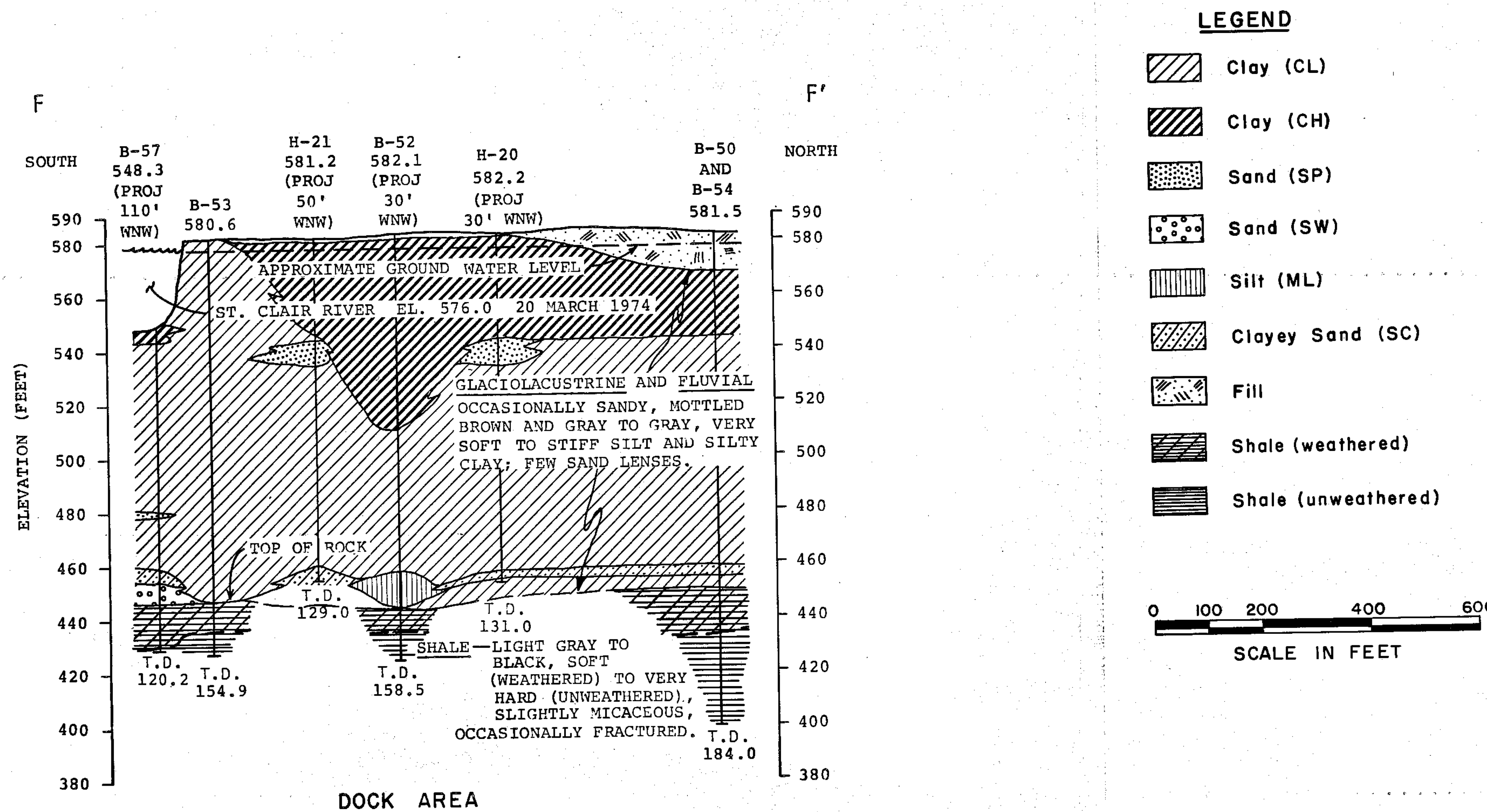
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION E-E'
SHEET 2 OF 2

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



NOTES:

1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

EXPLANATION

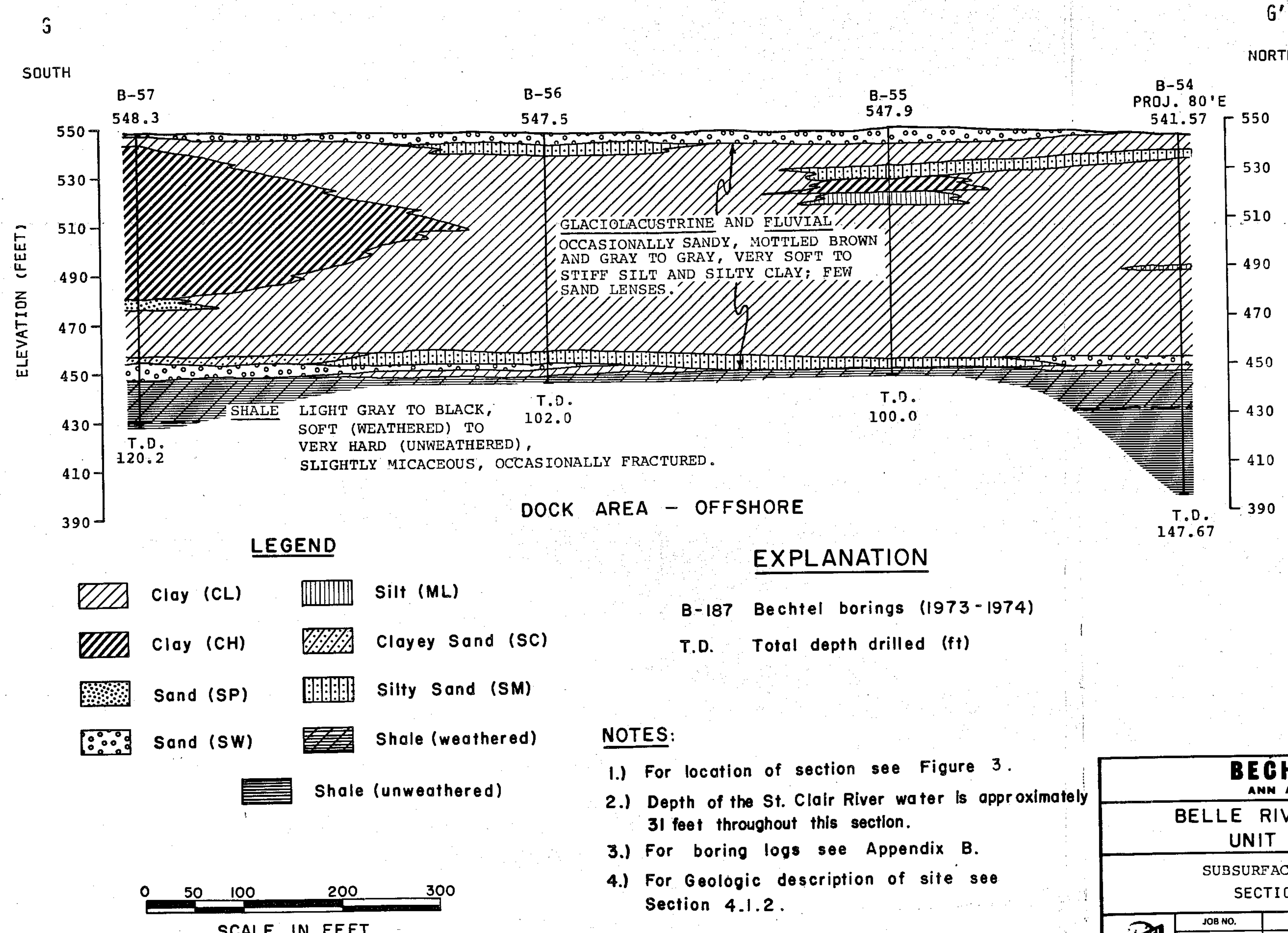
B-187	Bechtel borings (1973-1974)
H-15	Housel borings (1950-1967)
T.D.	Total depth drilled (ft)

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION F-F'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

NOTES:

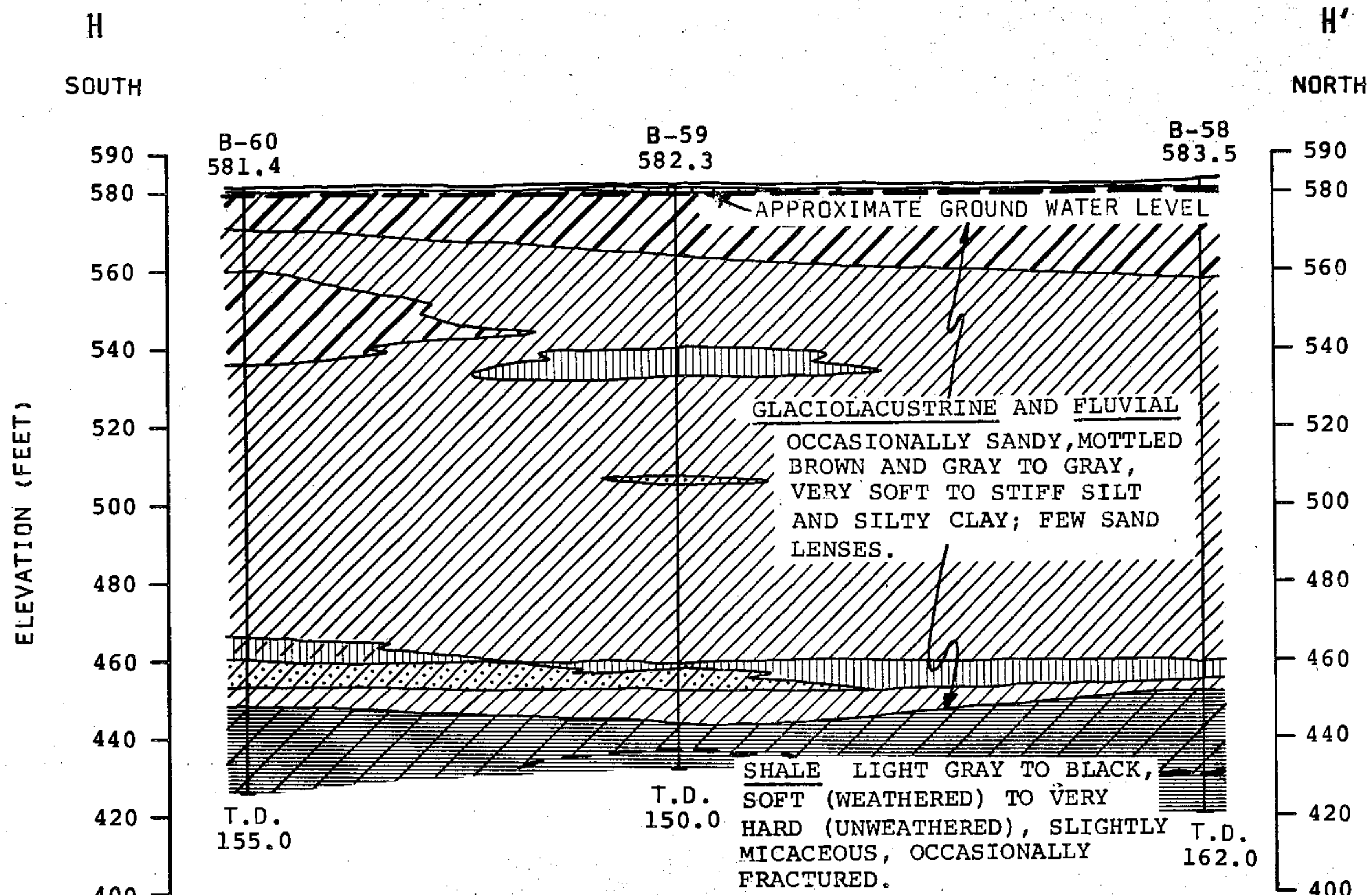
1.) For location of section see Figure 3.
2.) Depth of the St. Clair River water is approximately 31 feet throughout this section.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION G-G'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	O



DOCK AREA — TRANSFER HOUSES 1 & 2

LEGEND

- Clay (CL)
- Clay (CL-CH)
- Clayey Sand (SC)
- Silt (ML)
- Sand (SP)
- Shale (weathered)
- Shale (unweathered)

0 50 100 200 300

SCALE IN FEET

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

NOTES:

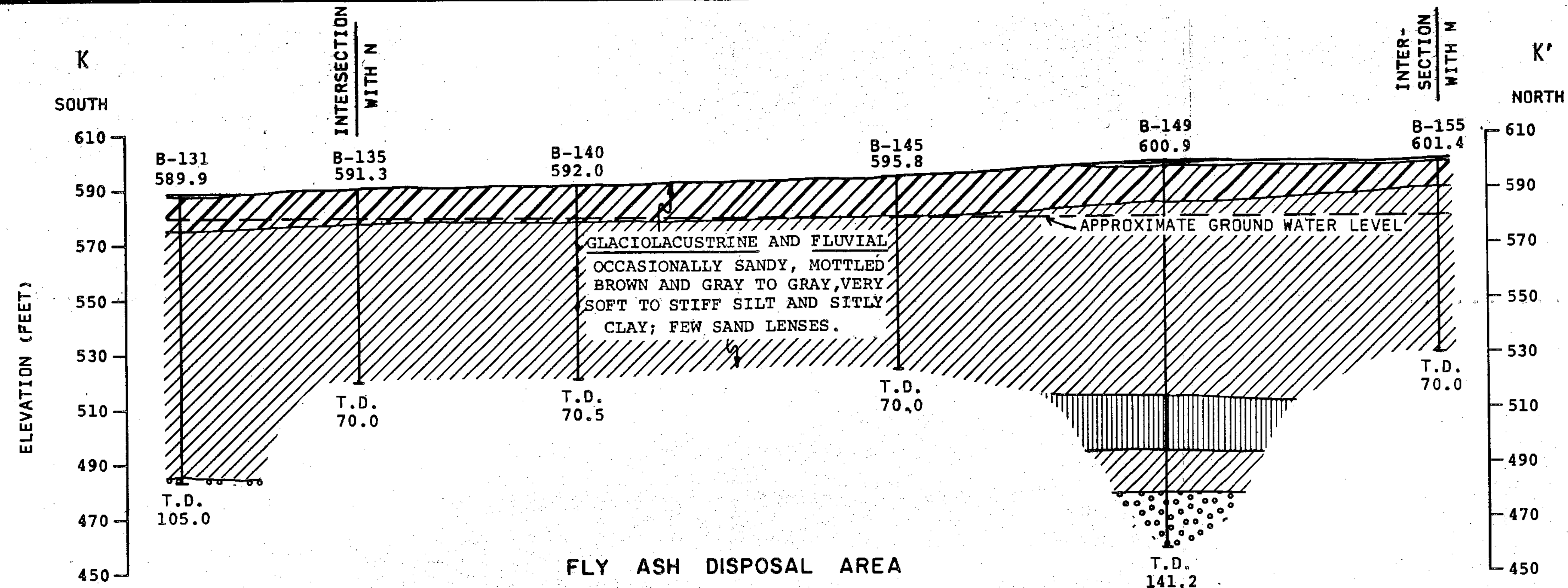
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION H-H'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



LEGEND

- Clay (CL)
- Clay (CL-CH)
- Sand (SW)
- Silt (ML)

EXPLANATION

B-187 Bechtel borings (1973 - 1974)

T.D. Total depth drilled (ft)

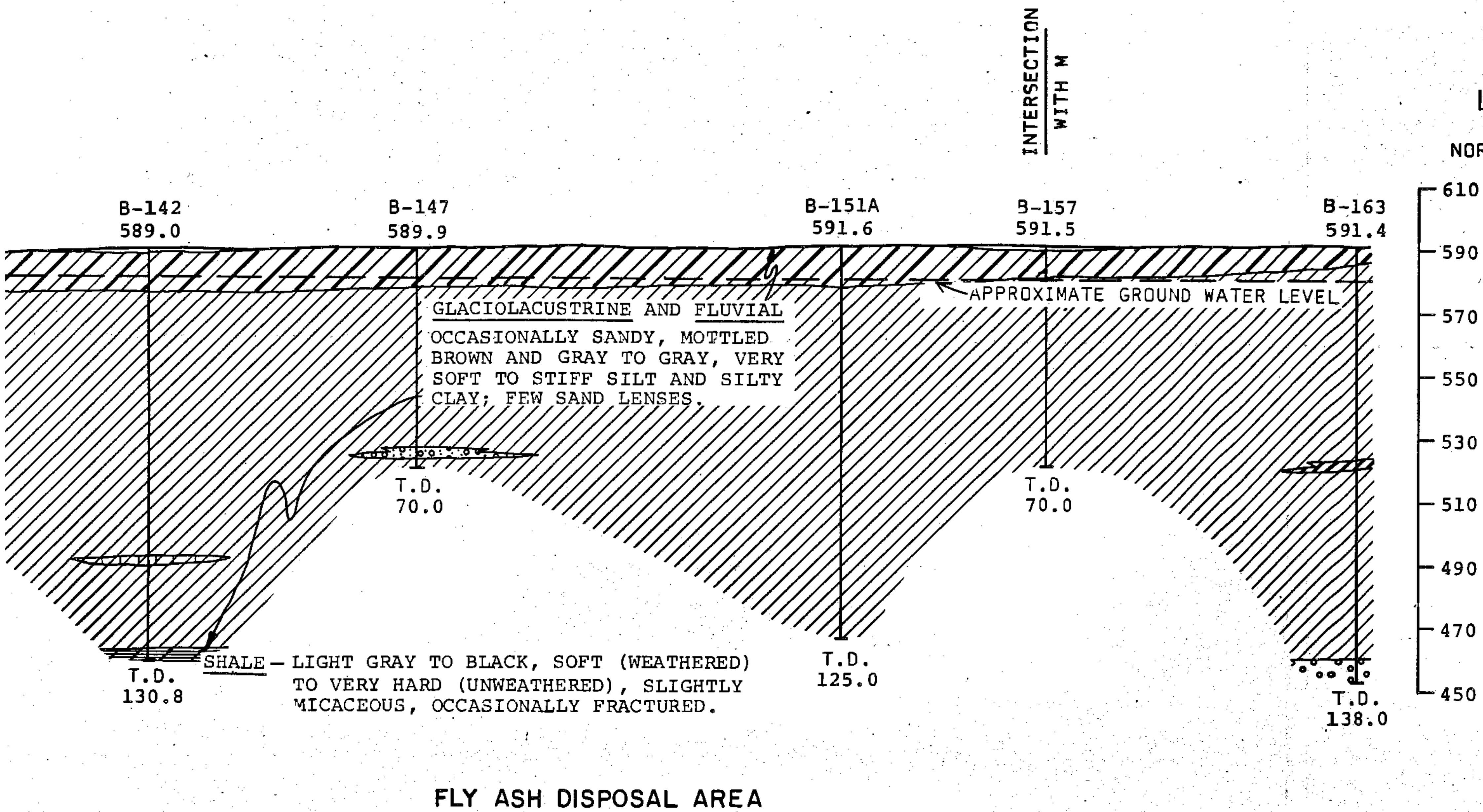
0 200 400 800 1200

SCALE IN FEET

NOTES:

1.) For location of section see Figure 4.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR	
BELLE RIVER PLANT UNIT 1 & 2	
SUBSURFACE PROFILE SECTION K-K'	
JOB NO. 10539	DRAWING NO. FIGURE 9
REV. 0	



NOTES:

1.) For location of section see Figure 4.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

0 200 400 800 1200

SCALE IN FEET

GEND

Sand (SW)

Silt (ML)

)

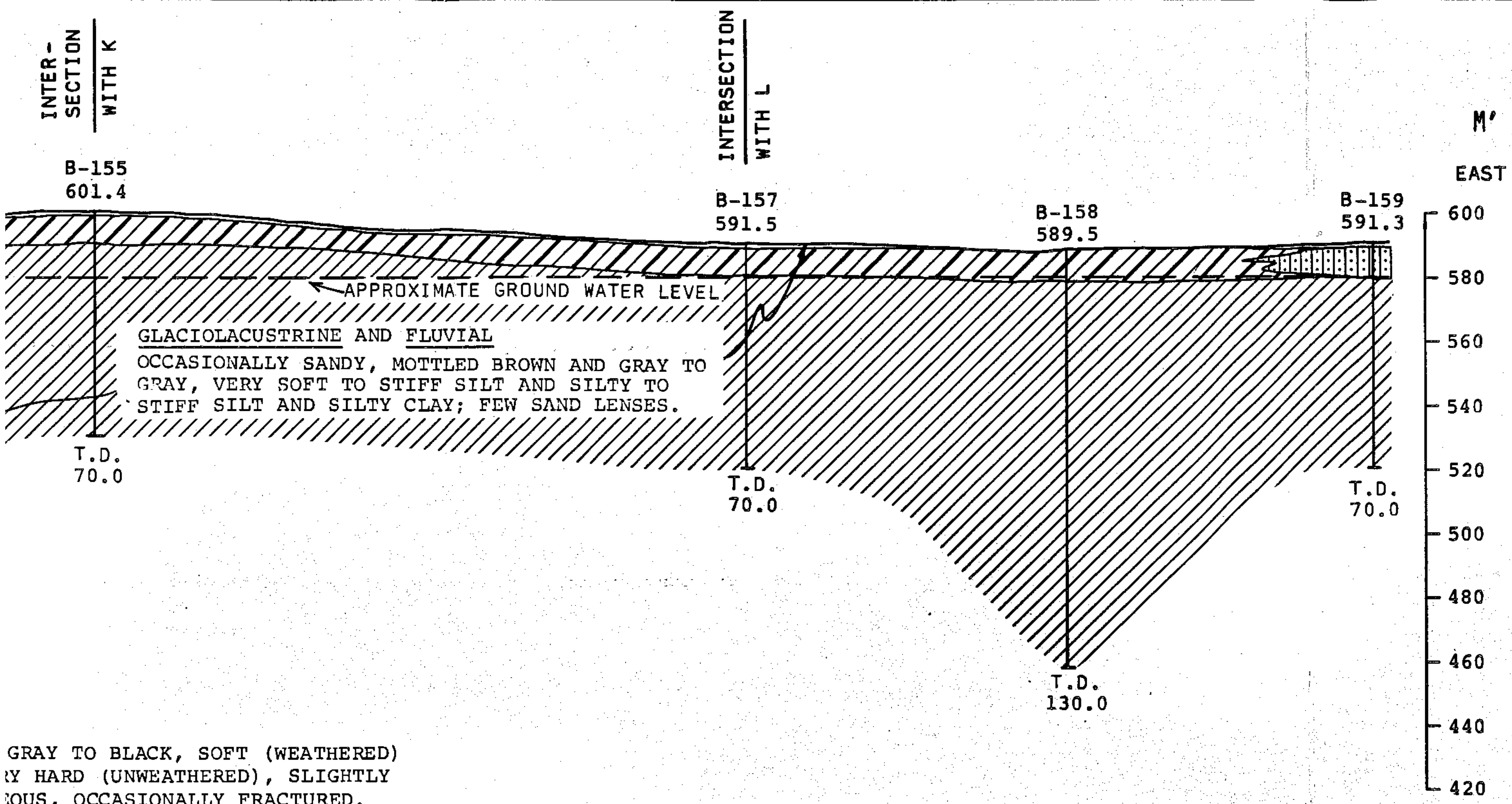
Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION L-L'		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



GRAY TO BLACK, SOFT (WEATHERED)
RY HARD (UNWEATHERED), SLIGHTLY
OUS, OCCASIONALLY FRACTURED.

FLY ASH DISPOSAL AREA

NOTES:

1.) For location of section see Figure 4.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

0 200 400 800 1200

SCALE IN FEET

LEGEND

ay (CL)	Silt (ML)
ay (CH)	Silty Sand (SM)
ay (CL-CH)	Clayey Sand (SC)
and (SP)	Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

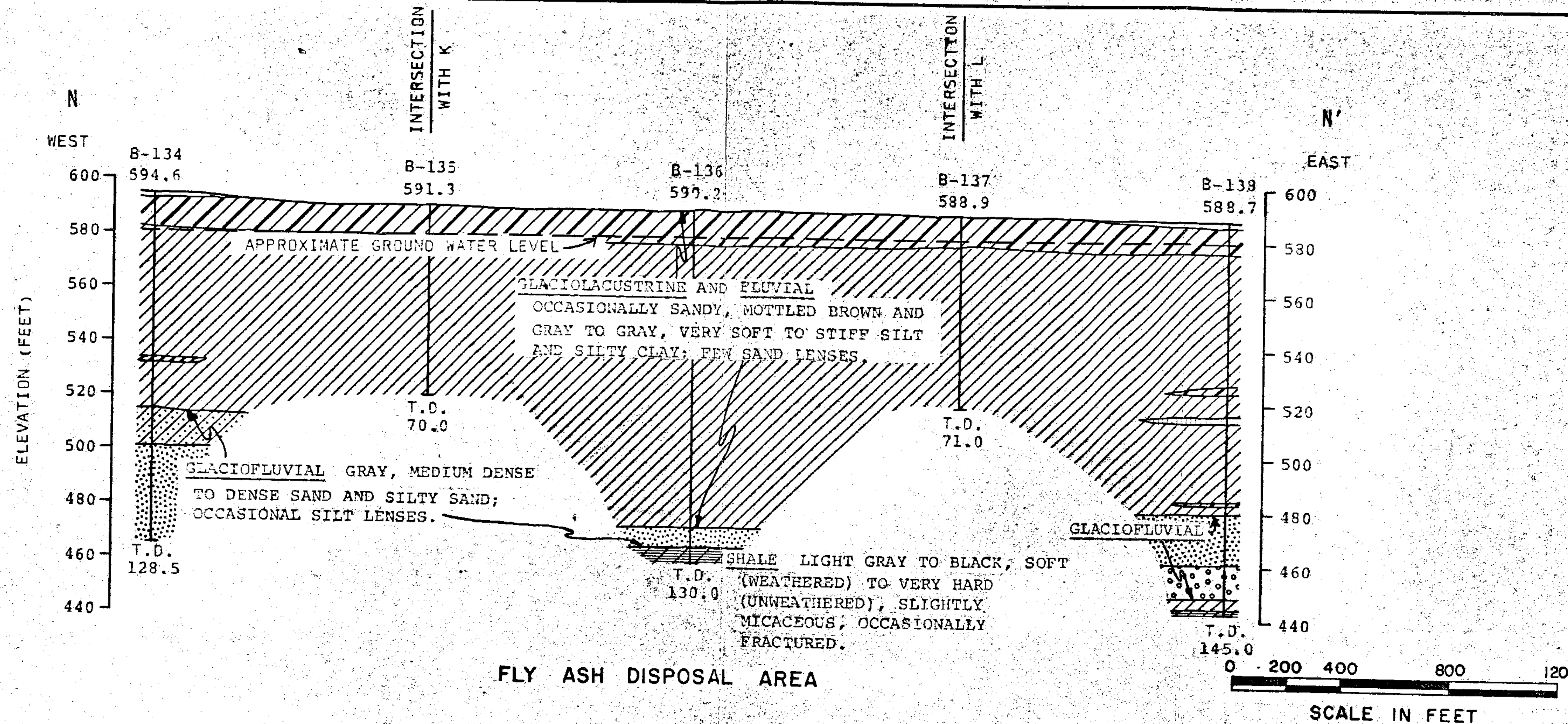
T.D. Total depth drilled (ft)

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION M-M'

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



LEGEND

- Clay (CL)
- Clay (CH)
- Clay (CL-CH)
- Sand (SP)
- Sand (SW)
- Silt (ML)
- Clayey Sand (SC)
- Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

NOTES:

1.) For location of section see Figure 4.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

NO.	DATE	REVISIONS	BY	CK'D	GROUP SUPV.	ENG'R	PROJ. ENG'R	MICRO FILM
	8/26/76	ISSUED FOR PROJ USE						
	6/13/76	ISSUED FOR FINAL EVAL						

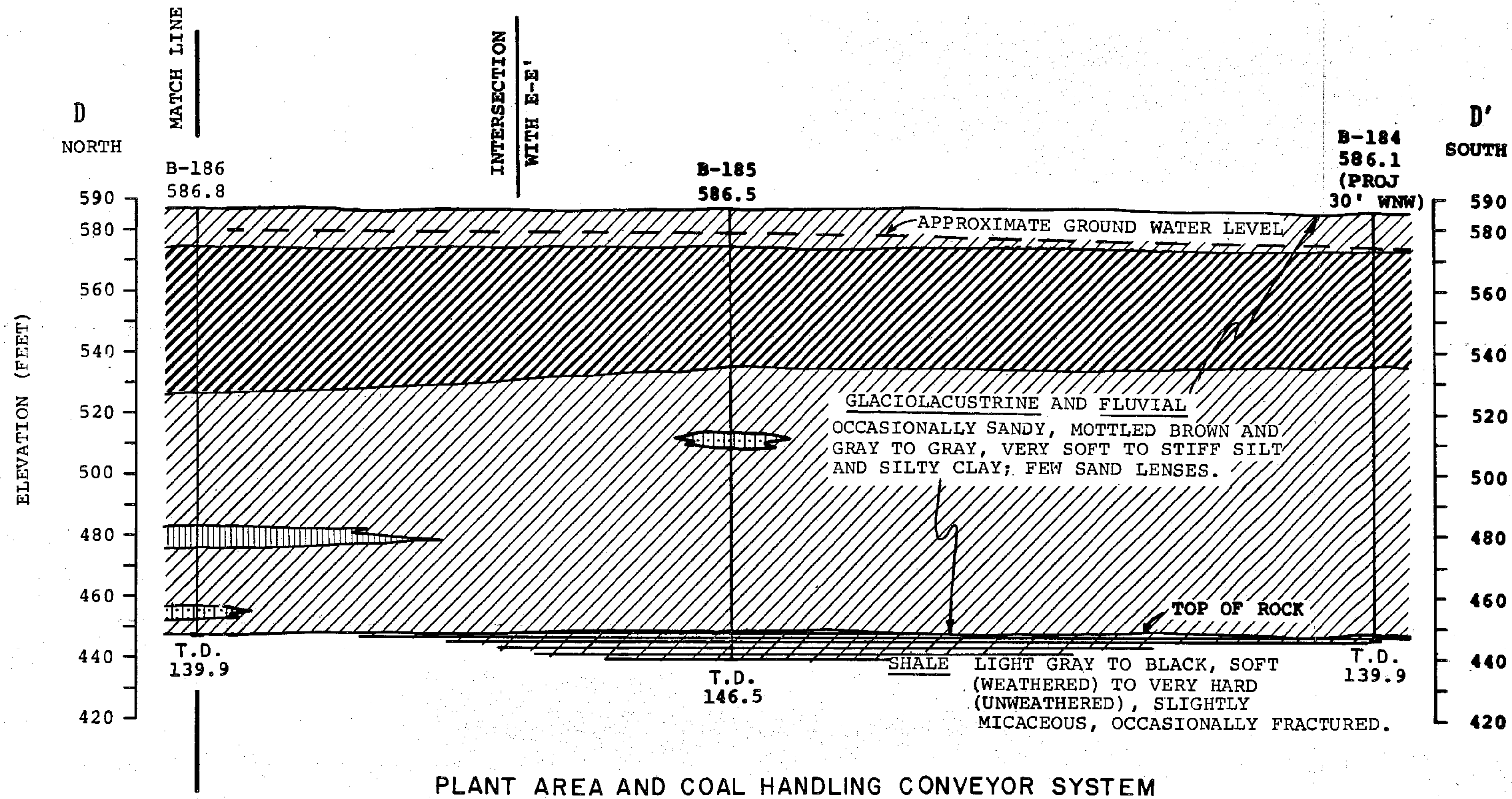
SCALE 1" = 400' DESIGNED DRG/JBG DRAWN ARR

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION N-N'

JOB NO. 10539 DRAWING NO. FIGURE 9 REV. 0



PLANT AREA AND COAL HANDLING CONVEYOR SYSTEM

LEGEND

- Clay (CL)
- Clay (CH)
- Silt (ML)
- Silty Sand (SM)
- Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

0 100 200 400 600

SCALE IN FEET

NOTES:

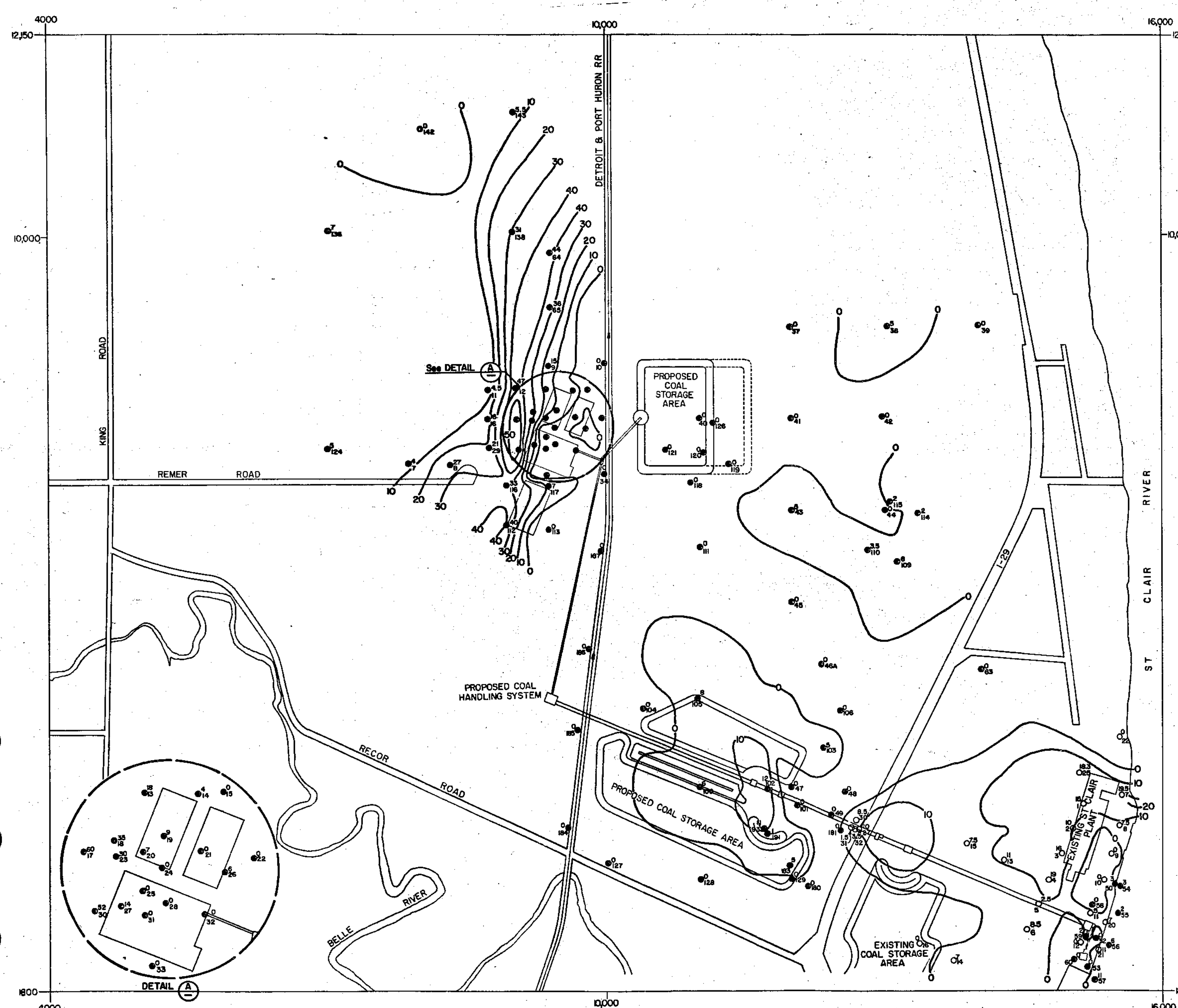
1.) For location of section see Figure 3.
2.) For variation of water table see Section 4.1.3.
3.) For boring logs see Appendix B.
4.) For Geologic description of site see Section 4.1.2.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

SUBSURFACE PROFILE
SECTION D-D'
SHEET 2 OF 2

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 9	0



EXPLANATION

- Basal sand thickness (ft)
- Boring number (present investigation)
- Basal sand thickness (ft)
- Boring number (previous investigations for St. Clair Plant)

NOTE: Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.

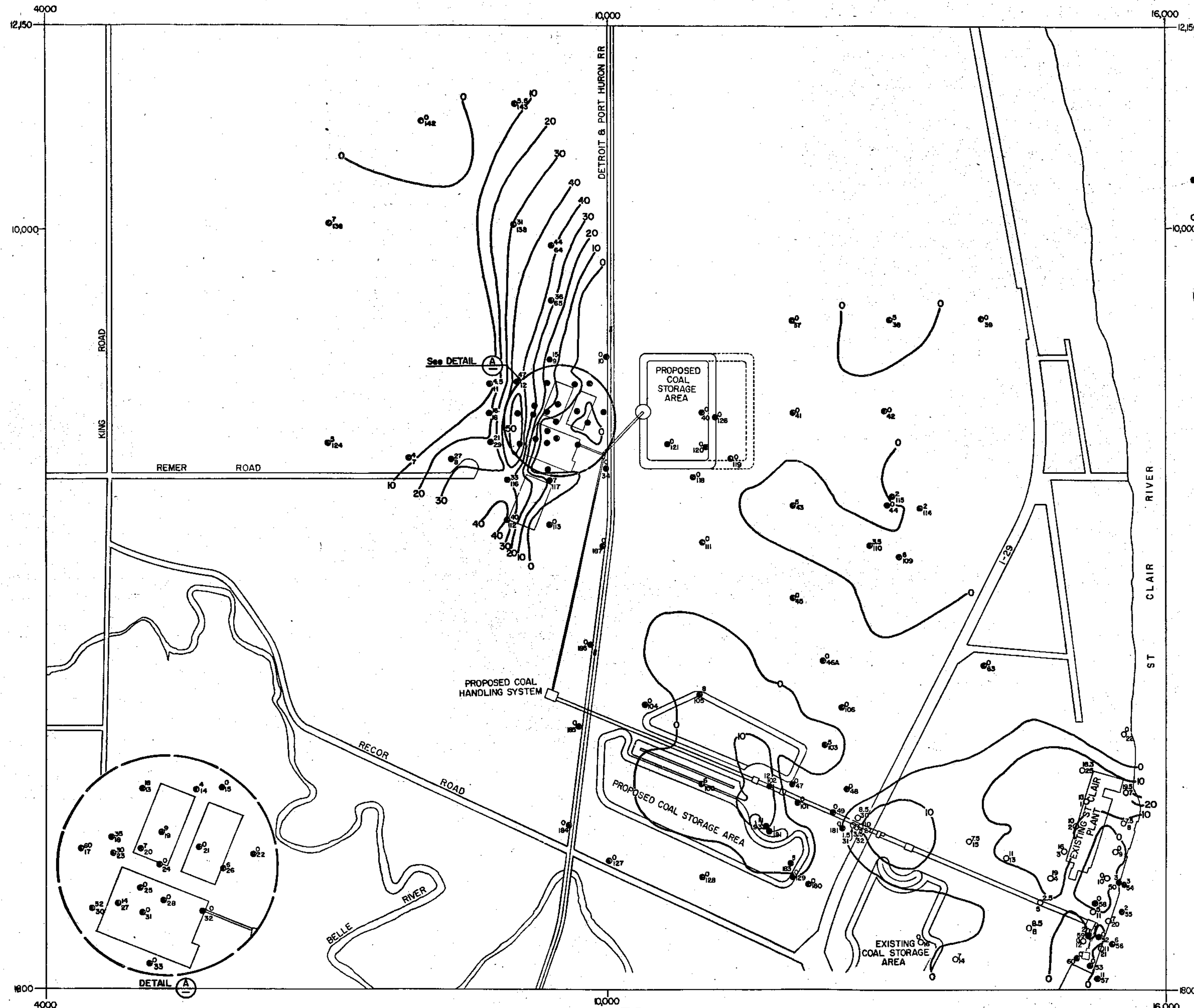
N

0 200 400 800 1200

SCALE IN FEET

CONTOUR INTERVAL = 10 FT

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
BASAL SAND THICKNESS CONTOUR MAP		
JOB NO. 10539	DRAWING NO. FIGURE 10	REV. 1



EXPLANATION

- 7 — Basal sand thickness (ft); 117 — Boring number (present investigation)
- 3.5 — Basal sand thickness (ft); 32 — Boring number (previous investigations for St. Clair Plant)

NOTE: Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.

0 200 400 800 1200

SCALE IN FEET

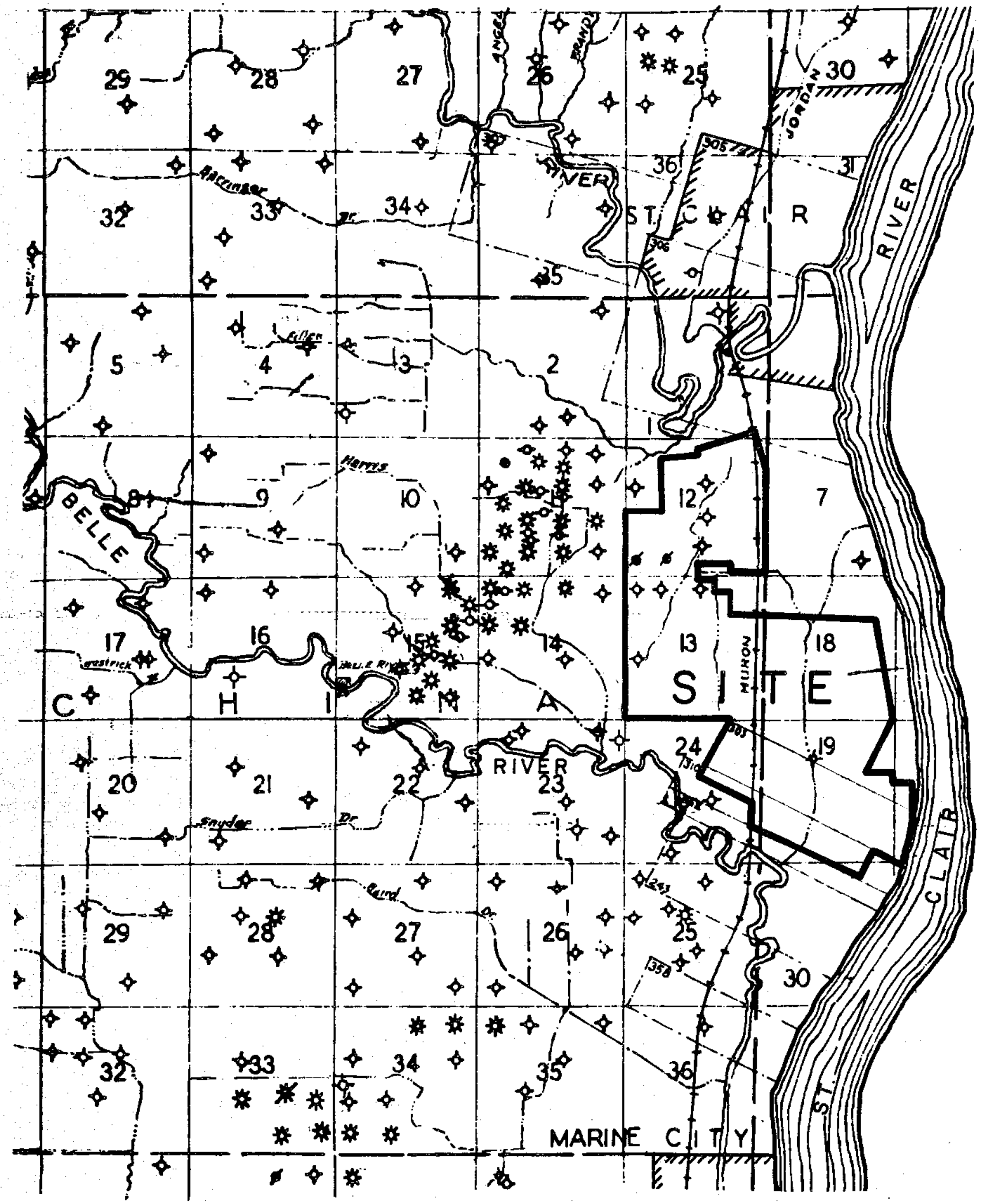
CONTOUR INTERVAL = 10 FT

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

BASAL SAND THICKNESS
CONTOUR MAP

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 10	1



N

EXPLANATION

- ● Oil Well
- ✳ Gas Well
- ✧ Dry Hole
- -o- Other
- ø Abandoned Well

REFERENCE:

Modified from Michigan Geological Survey Oil and Gas Well Map 3689A, St. Clair County.

0 1/2 1 2
SCALE IN MILES

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
LOCATION OF OIL AND GAS WELLS		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 12	0

APPROXIMATE DEPTH (FT)	ERA	PERIOD	ROCK GROUPS AND FORMATIONS	GRAPHIC LOG	LITHOLOGY	APPROXIMATE THICKNESS AT SITE
	CENOZOIC ERA QUATERNARY PERIOD		GLACIAL DRIFT		UNCONSOLIDATED DEPOSITS OF SAND, SILT AND CLAY. TWO MAJOR TYPES OCCUR: GLACIOLACUSTRINE-FLUVIAL CLAYS AND SILTS AND GLACIOFLUVIAL SANDS	133-157 (FT)
	PALEOZOIC	MISS.-DEVONIAN	BEDFORD SHALE		GRAY AND DARK GRAY SHALE	100
	PALEOZOIC	MISS.-DEVONIAN	ANTRIM SHALE		BLACK AND DARK BROWN SHALE WITH SOME PYRITE AND MARCASITE	200
	PALEOZOIC	DEVONIAN	TRAVERSE GROUP		GRAY, LIGHT GRAY, AND BROWN CHERTY LIMESTONE WITH BEDS OF GRAY SHALE. GRAY AND BLUE SHALE BELOW WITH MINOR LIMESTONE BEDS	240
	PALEOZOIC	DEVONIAN	DUNDEE LIMESTONE		BUFF, GRAY, AND BROWNISH-GRAY FINELY CRYSTALLINE LIMESTONE	130
1000	PALEOZOIC	DEVONIAN	DETROIT RIVER GROUP		BUFF TO WHITE LIMESTONE AND DOLOMITE WITH ANHYDRITE	360
	PALEOZOIC	DEVONIAN	BOIS BLANC FORMATION		WHITE TO GRAY CHERTY LIMESTONE AND DOLOMITE	90
	PALEOZOIC	SILURIAN	BASS ISLAND GROUP		BUFF TO CREAM DOLOMITE WITH MINOR ANHYDRITE	135
2000	PALEOZOIC	SILURIAN	SALINA GROUP		GRAY SHALE WITH SOME DOLOMITE BROWN LIMESTONE AND SALT GRAY SHALE AND SALT BROWN DOLOMITE WITH ANHYDRITE AND SALT	1100
	PALEOZOIC	SILURIAN	NIAGARA GROUP		GRAY, TAN, AND BROWN DOLOMITE WITH ANHYDRITE IN TOP SECTION, SHALE BELOW	400
3000	PALEOZOIC	SILURIAN	CATARACT GROUP		RED AND BLUE SHALE AND LIGHT GRAY BLUE DOLOMITE	160
4000	PALEOZOIC	ORDOVICIAN	(UNDIFFERENTIATED)		PRIMARILY DOLOMITE AND SANDSTONE WITH SHALE AND MINOR LIMESTONE	1550
	PALEOZOIC	CAMBRIAN	(UNDIFFERENTIATED)		PRIMARILY SANDSTONE WITH LIMESTONE AND DOLOMITE	100
	PRECAMBRIAN				IGNEOUS, METAMORPHIC AND SEDIMENTARY ROCKS	UNKNOWN

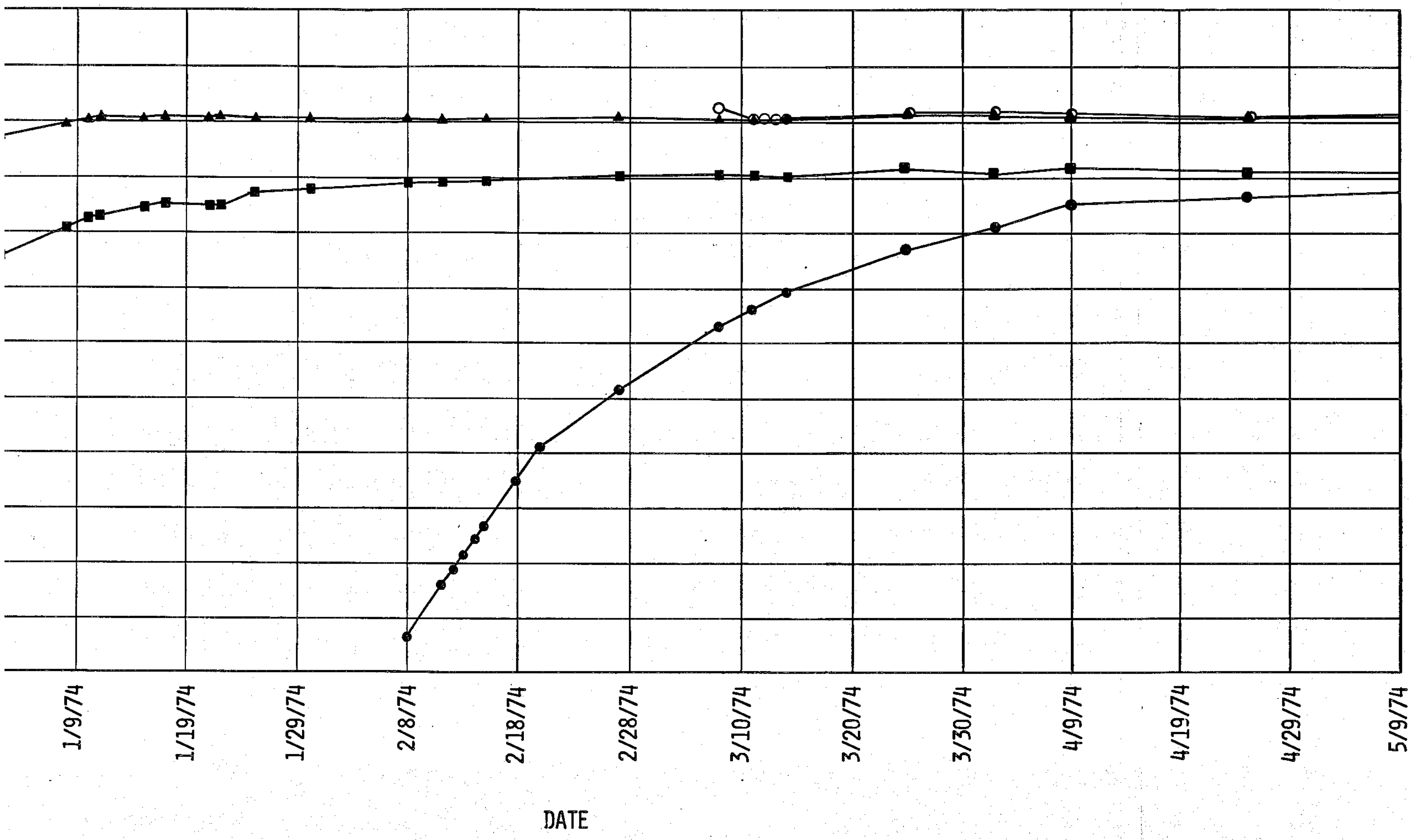
EXPLANATION

- Glacial Drift
- Shale
- Limestone
- Cherty Limestone
- Dolomite
- Anhydrite
- Salt
- Sandstone
- Igneous, Metamorphic, and Sedimentary Rock Complex

NOTE:

Overburden thickness determined from Bechtel logs. Thickness and description of geologic bedrock units above the Niagara group are based on logs of Wildcat wells drilled in China and East China Townships. These logs are on file with the Michigan Geological Survey in Lansing. Thickness and description of units below the Salina group were interpolated from Stratigraphic Cross-section Michigan Basin, Michigan Basin Geological Society, 1969; and Michigan's Oil and Gas Fields, 1972; Michigan Geological Annual Statistical Summary No. 18, 1973.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
GENERALIZED GEOLOGIC COLUMN CHINA AND EAST CHINA TOWNSHIPS		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 13	1



EXPLANATION

- ■ Observation Well 7, bottom of screen at Elevation 450.5
- ● Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- ○ Observation Well 181, bottom of screen at Elevation 449.3

NOTE:

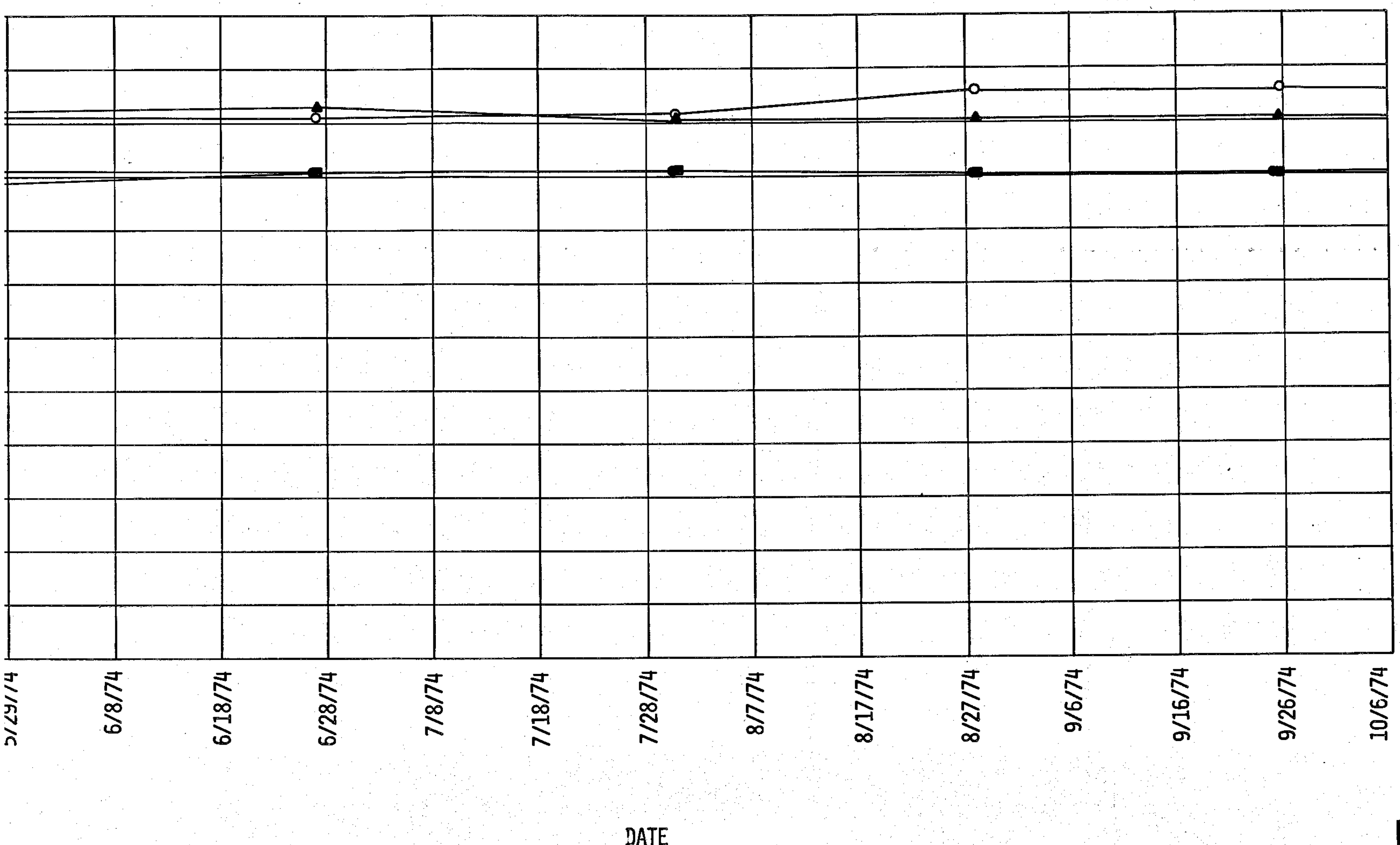
For location of Observation Wells see Figure 3.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

HYDROGRAPHS OF OBSERVATION WELLS
SHEET 1 OF 3

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 14	1



EXPLANATION

- ■ Observation Well 7, bottom of screen at Elevation 450.5
- ● Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- ○ Observation Well 181, bottom of screen at Elevation 449.3

NOTE

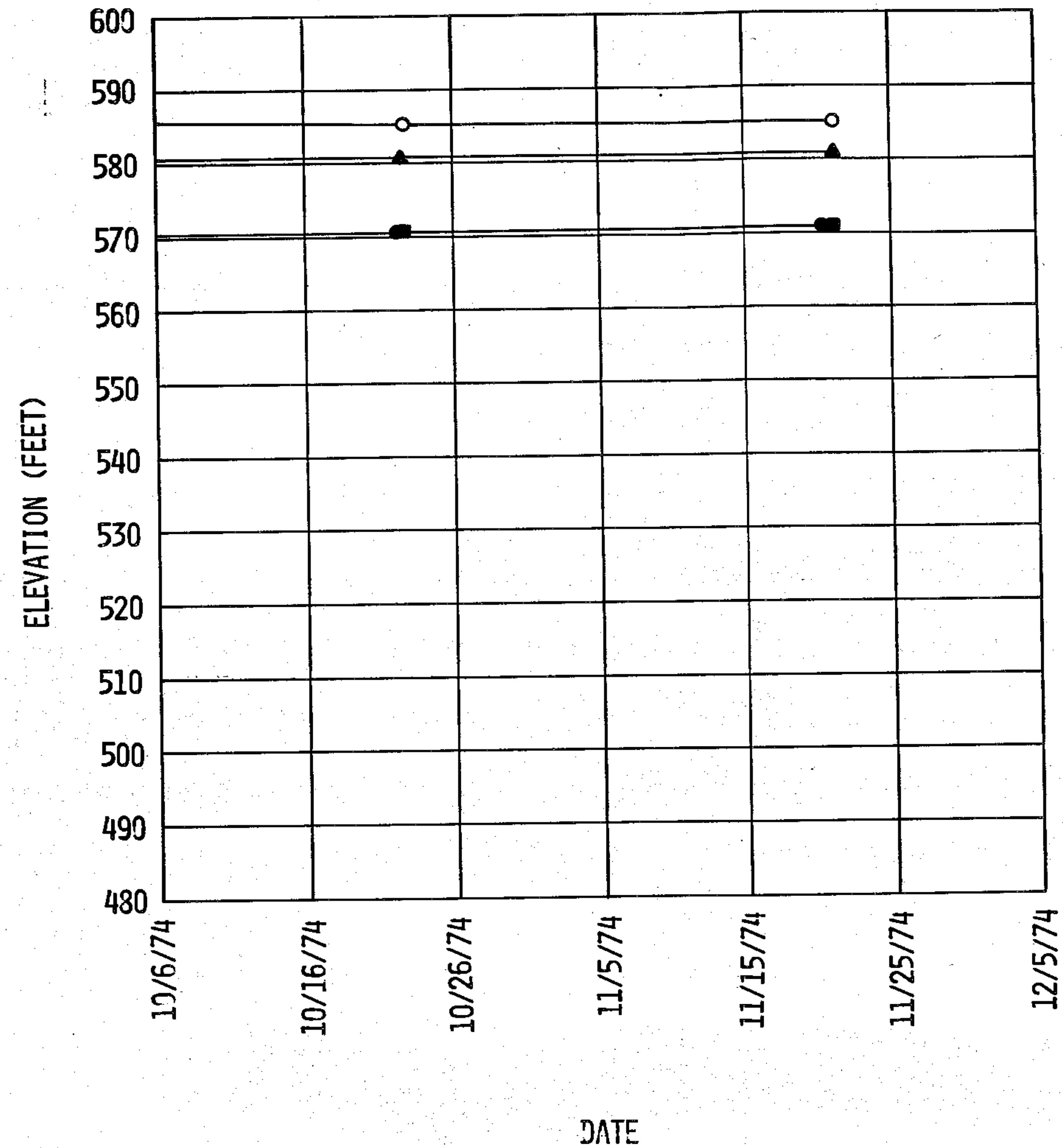
For location of Observation Wells see Figure 3.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

HYDROGRAPHS OF OBSERVATION WELLS
SHEET 2 OF 3

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 14	1



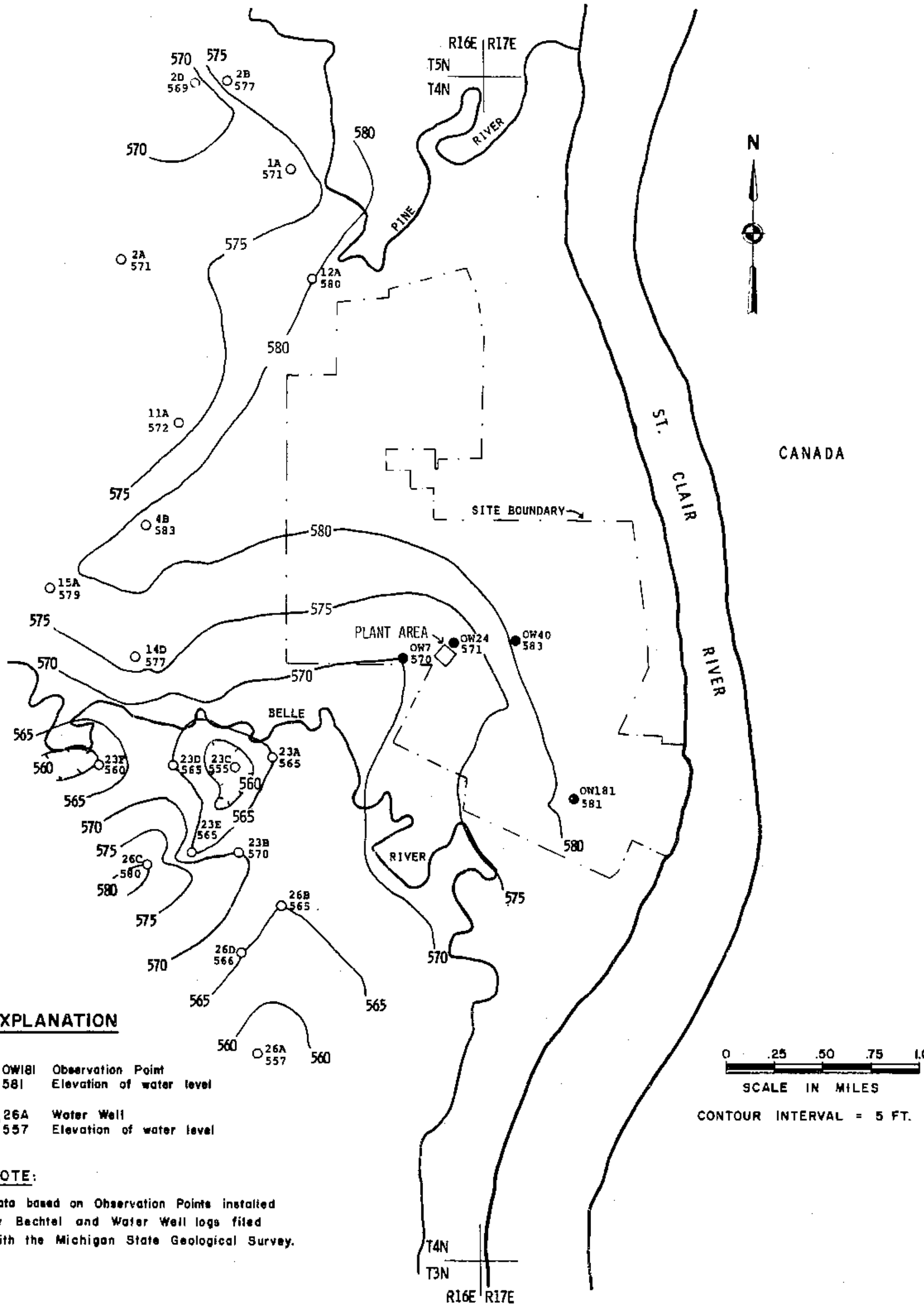
EXPLANATION

- ■ Observation Well 7, bottom of screen at Elevation 450.5
- ● Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- ○ Observation Well 181, bottom of screen at Elevation 449.3

NOTE:

For location of Observation Wells see Figure 3.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
HYDROGRAPHS OF OBSERVATION WELLS SHEET 3 OF 3		
JOB NO. 10539	DRAWING NO. FIGURE 14	REV. 1



EXPLANATION

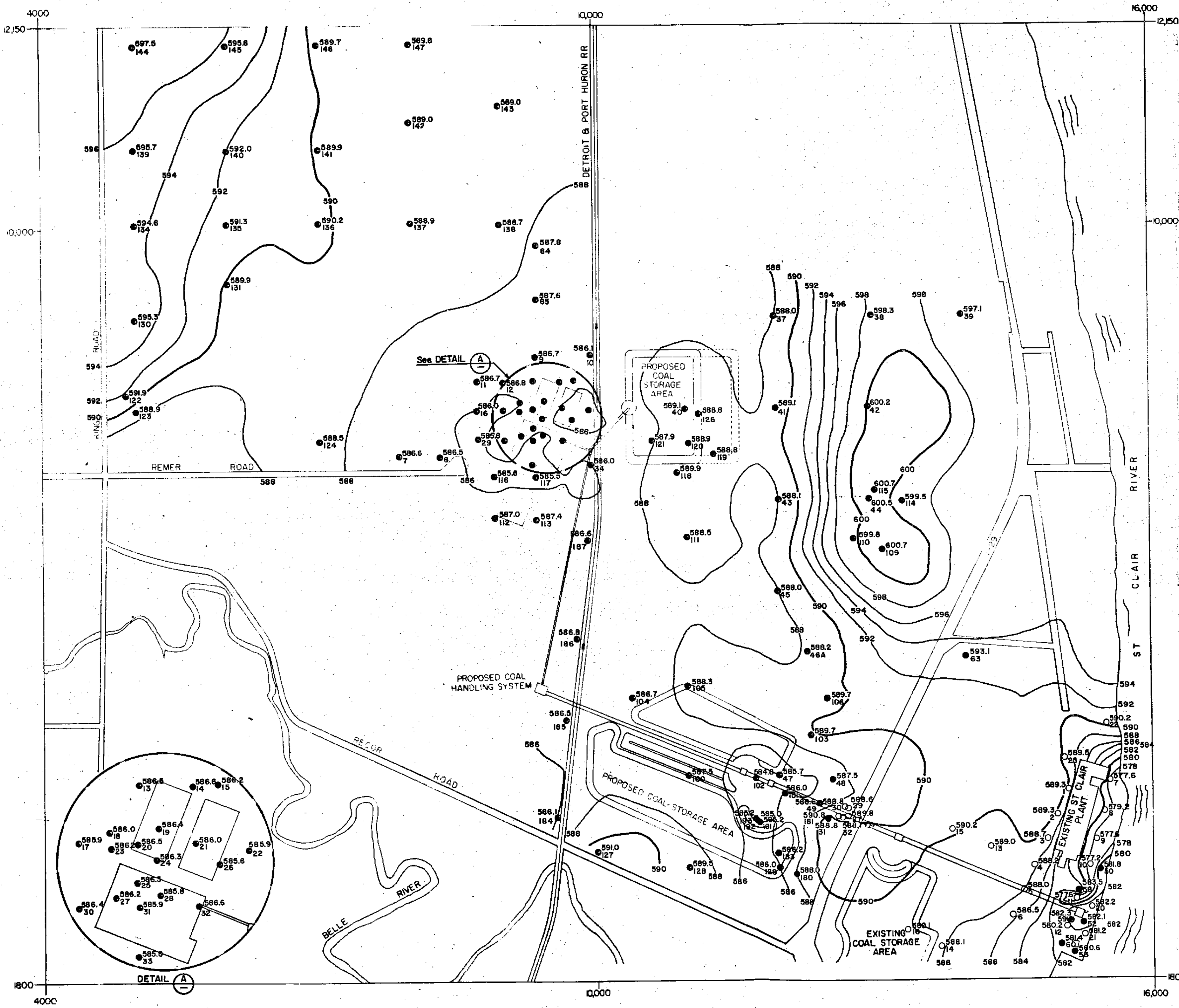
○ OW181 581 — Observation Point, Elevation of water level

● 26A 557 — Water Well, Elevation of water level

NOTE:

Data based on Observation Points installed by Bechtel and Water Well logs filed with the Michigan State Geological Survey.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
GROUND WATER LEVEL CONTOUR MAP		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 15	1



EXPLANATION

586.6 — Ground surface elevation (ft)
187 — Boring number (present investigation)

588.7 — Ground surface elevation (ft)
32 — Boring number (previous investigations for St Clair plant)

NOTES:

1. Contours generated from drill hole data by McDonnell Douglas Automation Company's **SURMAP** computer program.
2. Computer interpretation modified manually to accommodate additional data points.
3. Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.

N

0 200 400 800 1200
SCALE IN FEET

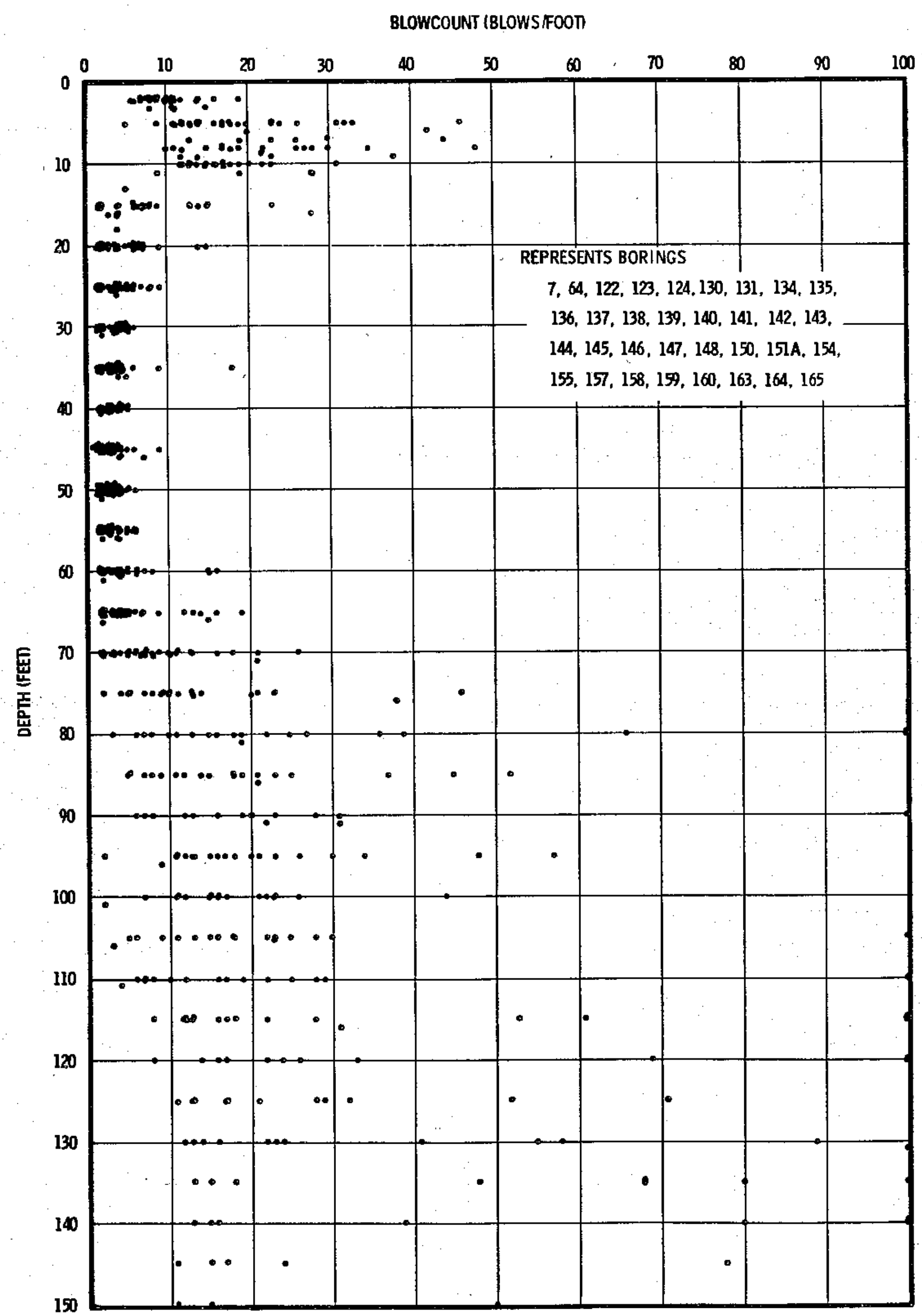
CONTOUR INTERVAL = 2 FT

BECHTEL
ANN ARBOR

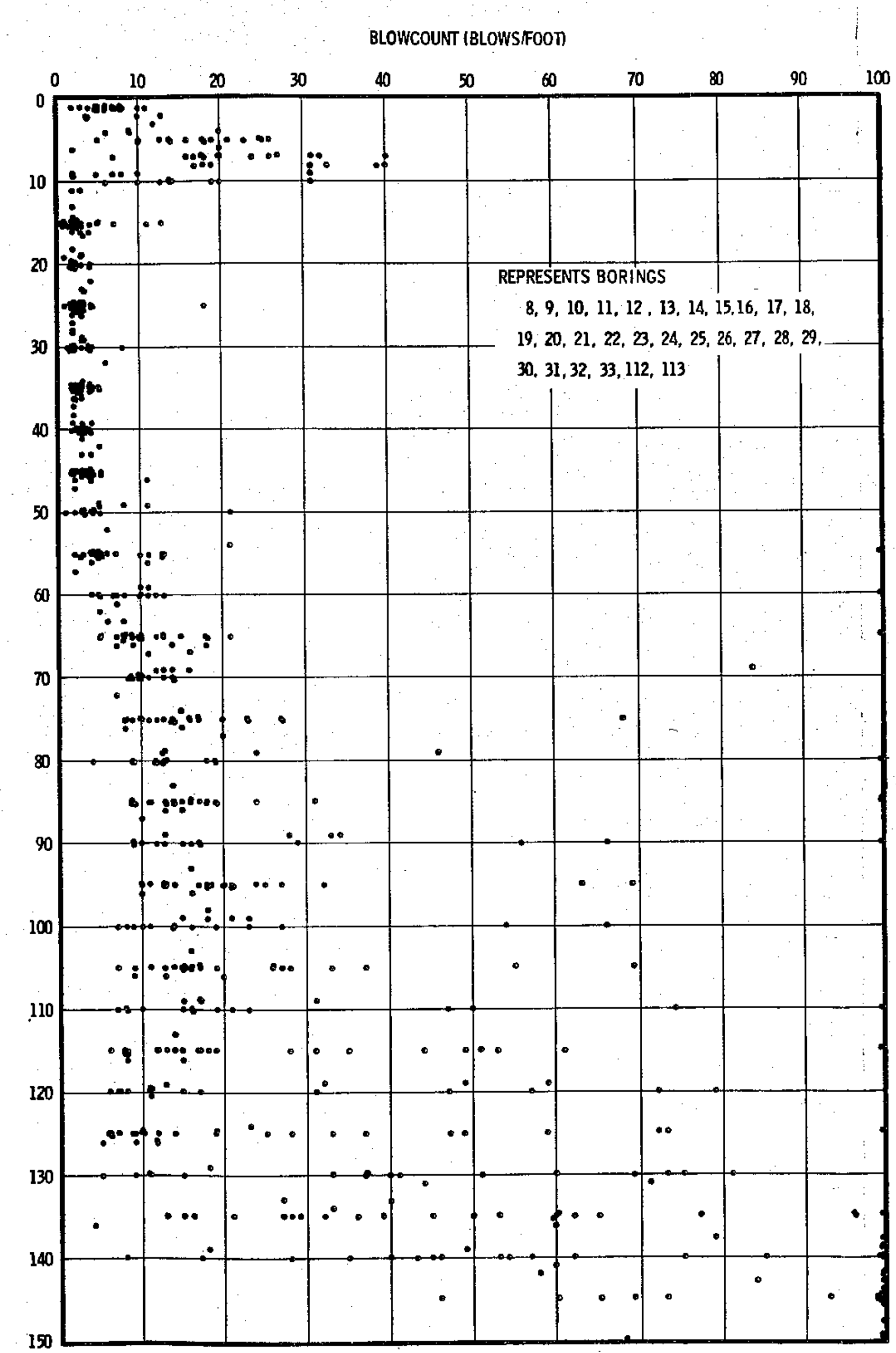
BELLE RIVER PLANT
UNIT 1 & 2

GROUND SURFACE CONTOUR MAP

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 16	1

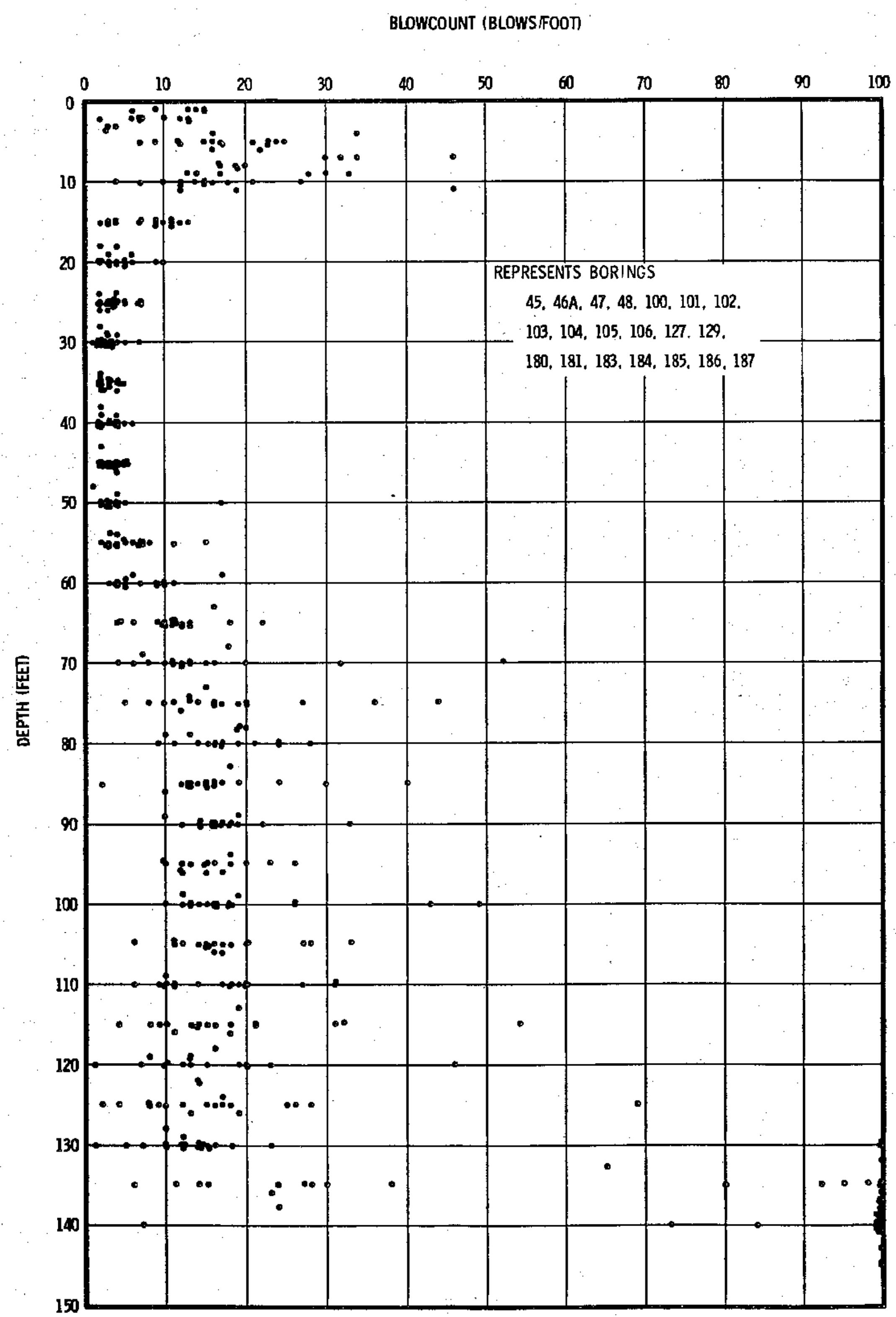


NORTH AREA

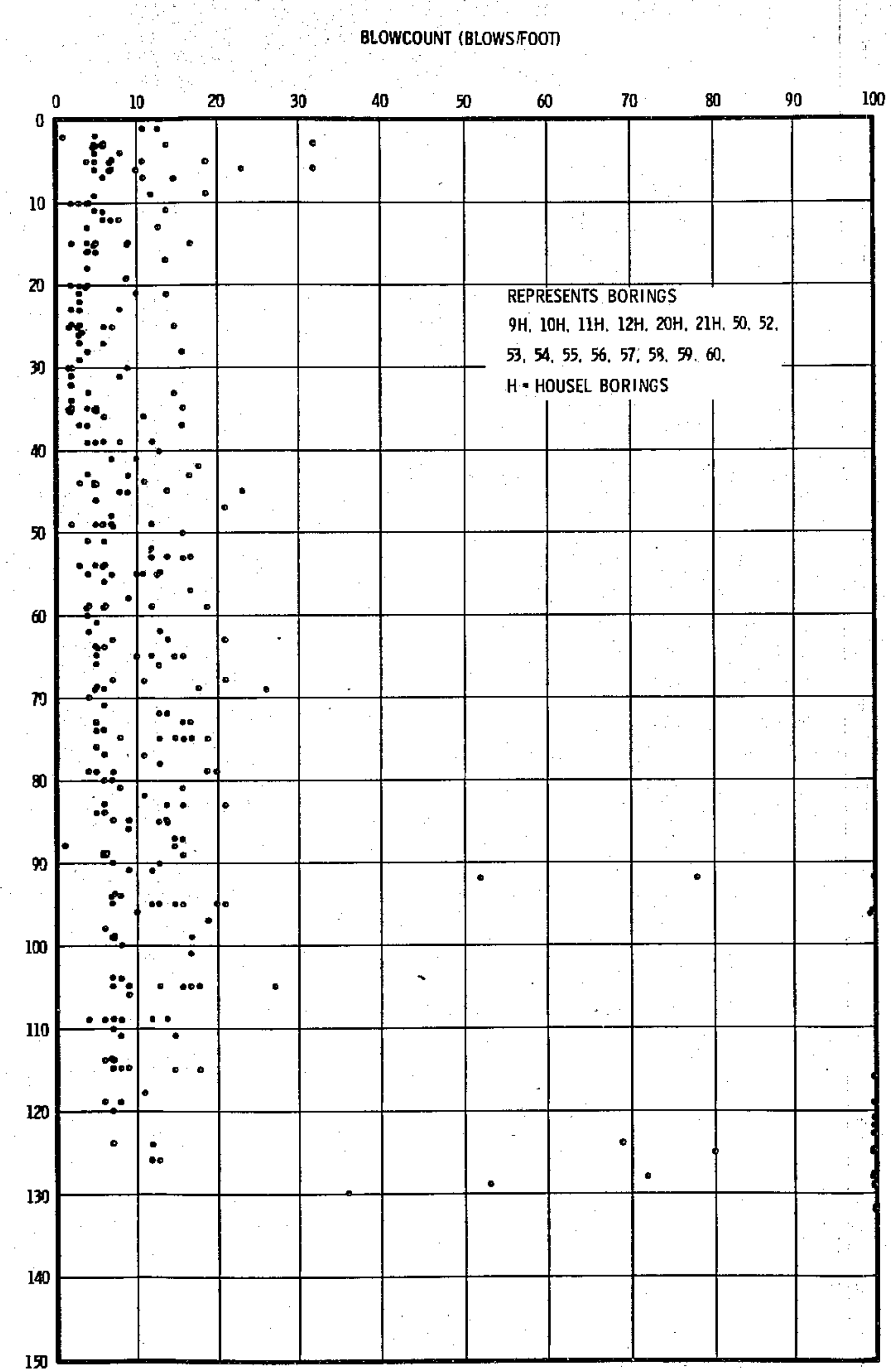


MAIN PLANT AREA

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
BLOWCOUNT vs DEPTH SHEET 1 OF 2		
JOB No.	DRAWING No.	REV.
10539	FIGURE 17	0



COAL STORAGE AREA



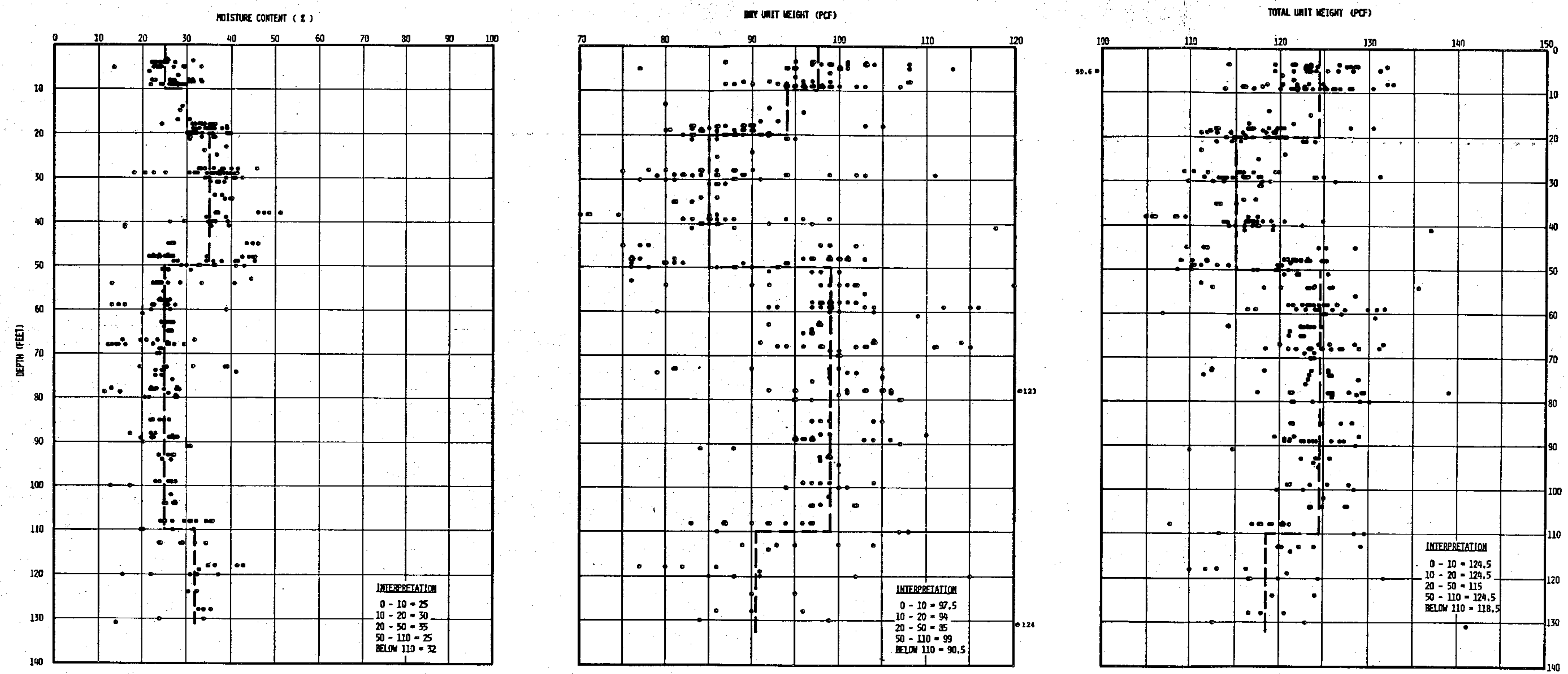
DOCK AREA

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNITS 1 & 2

BLOWCOUNT vs DEPTH
SHEET 2 OF 2

JOB No.	DRAWING No.	REV.
10539	FIGURE 17	O



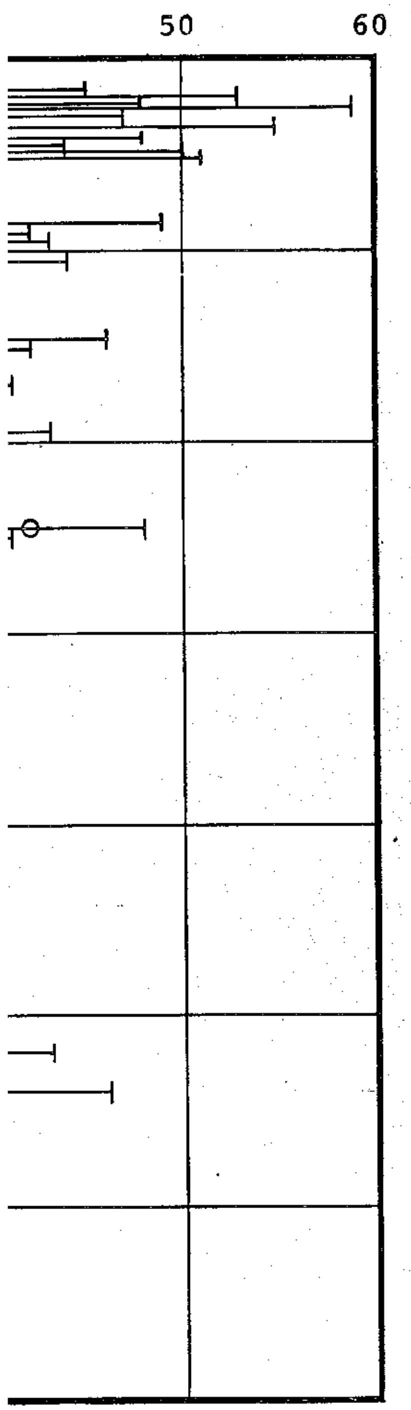
NOTE: DATA INCLUDES RESULTS OF ALL TESTS PERFORMED THROUGHOUT THE ENTIRE SITE.

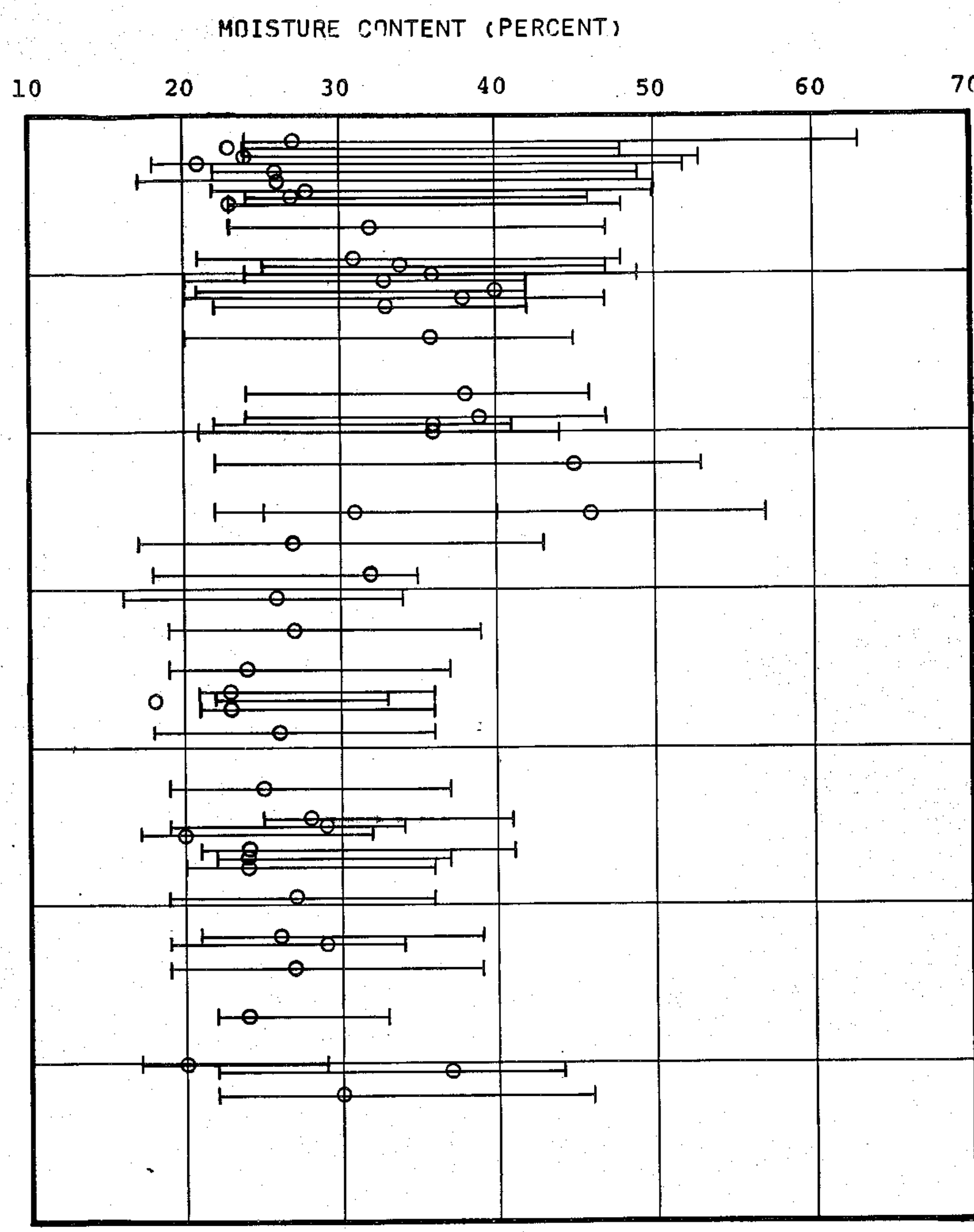
BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

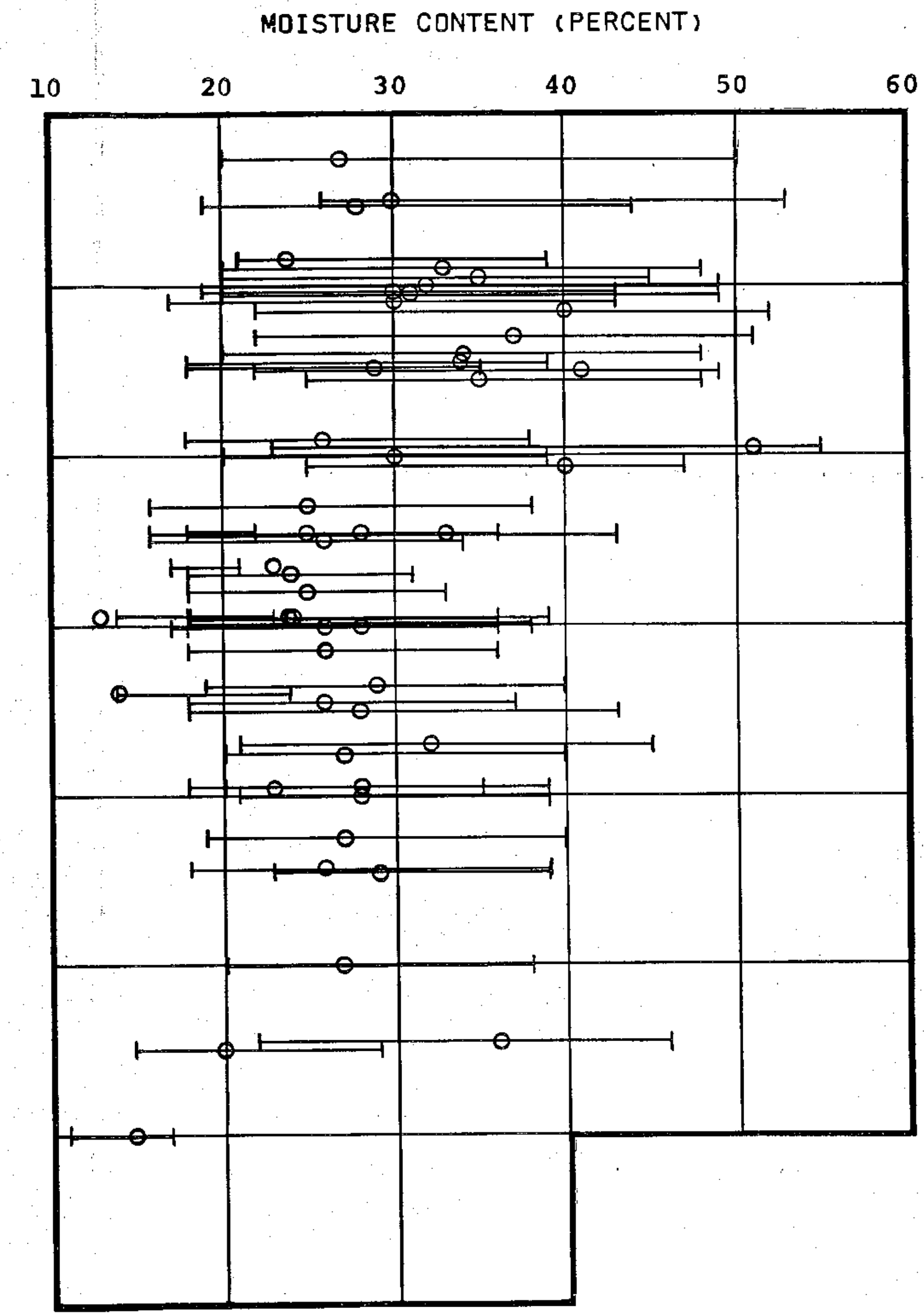
MOISTURE CONTENT, DRY UNIT WEIGHT, AND TOTAL UNIT WEIGHT VS DEPTH

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 18	0





MAIN COAL STORAGE AREA



DOCK AREA

LEGEND

W: NATURAL MOISTURE CONTENT

PL: PLASTIC LIMIT

LL: LIQUID LIMIT

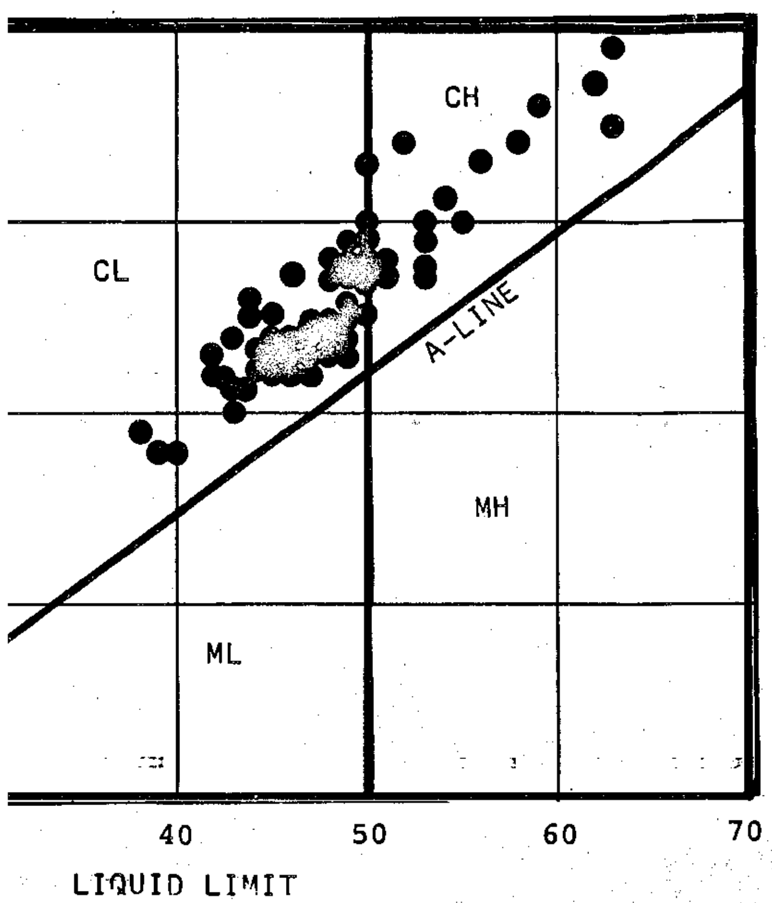
PL W LL

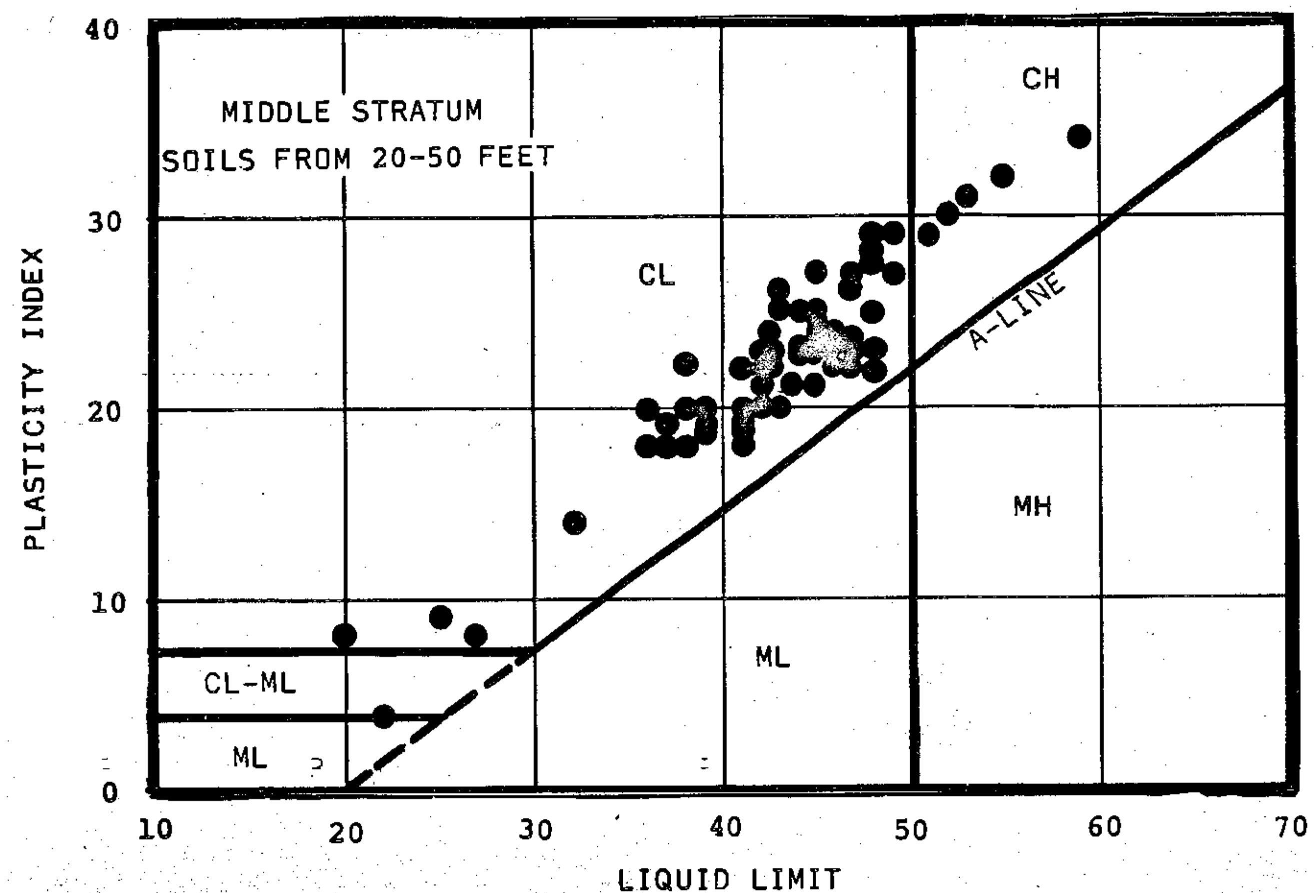
BECHTEL
ANN ARBOR

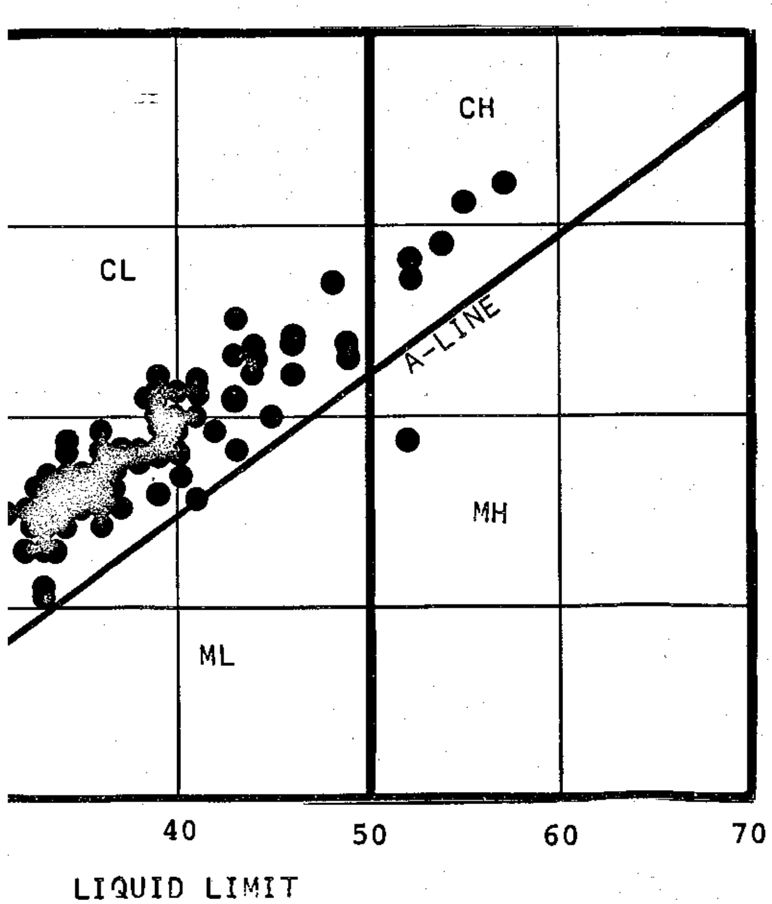
BELLE RIVER PLANT
UNIT 1 & 2

ATTERBERG LIMITS AND NATURAL MOISTURE CONTENT VS DEPTH

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 20	0





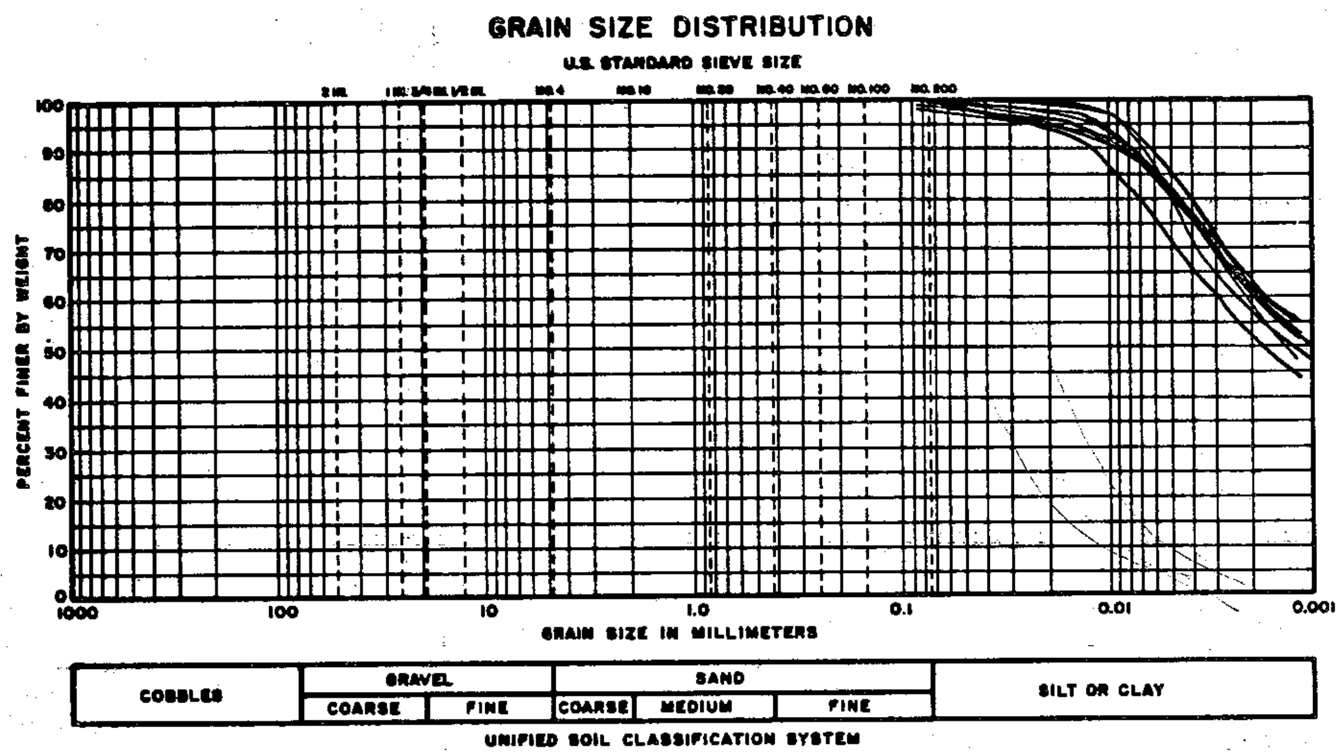


BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

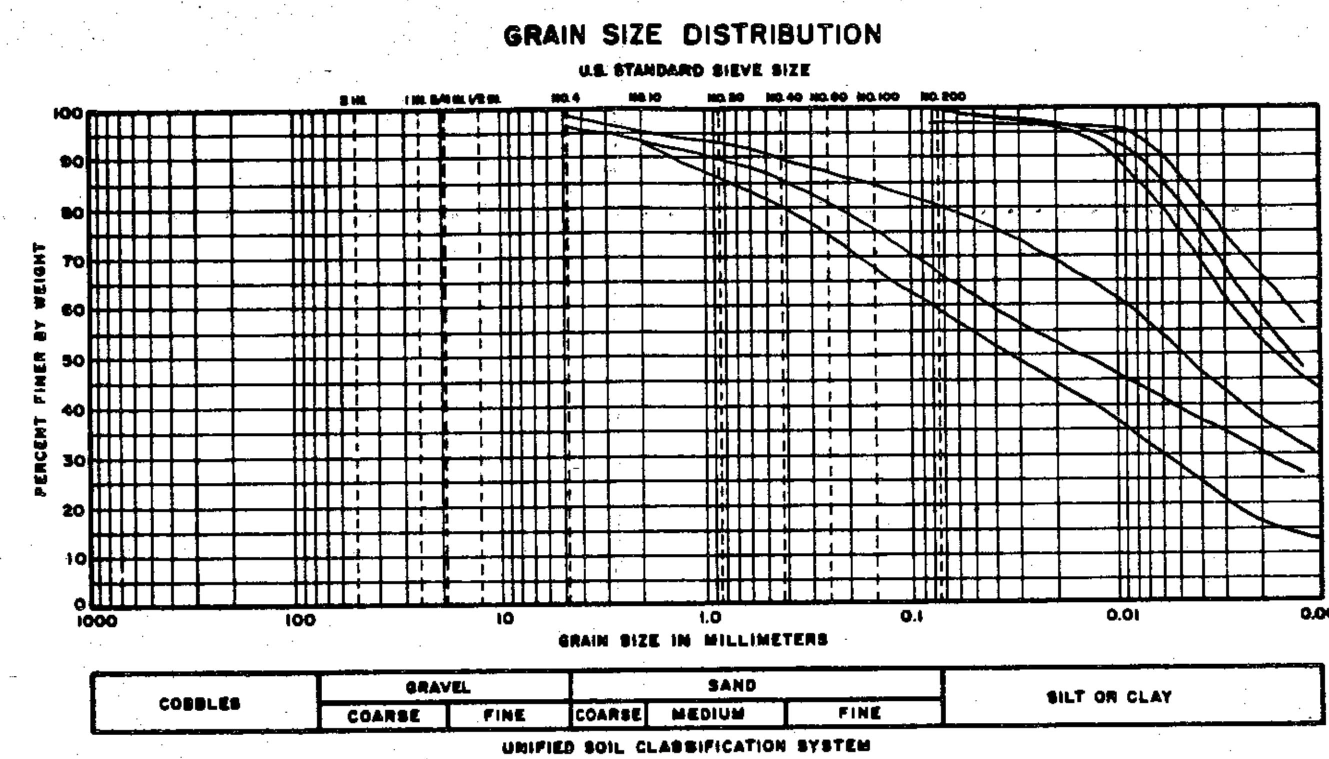
PLASTICITY CHART

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 19	0



UPPER STRATUM (0-20 FEET)

BORING NUMBER	SAMPLE DEPTH (FEET)
38 (CL-CH)	9
38 (CL-CH)	15
41 (CH)	5
48 (CL-CH)	9
60 (CL-CH)	5
60 (CL)	11
60 (CL)	18
60 (CL)	19
137 (CL-CH)	2
144 (CL)	14
151A (CL-CH)	8



MIDDLE STRATUM (20-50 FEET)

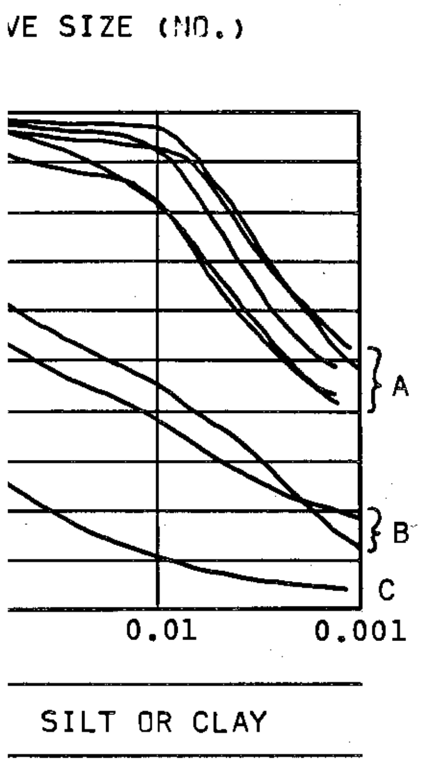
	BORING NUMBER	SAMPLE DEPTH (FEET)
A	41 (CL)	20
B	41 (SC)	40
C	50 (CL)	28
D	50 (CL)	48
E	53 (CL)	39
F	60 (CL-CH)	27

BECHTEL
ANN ARBOR

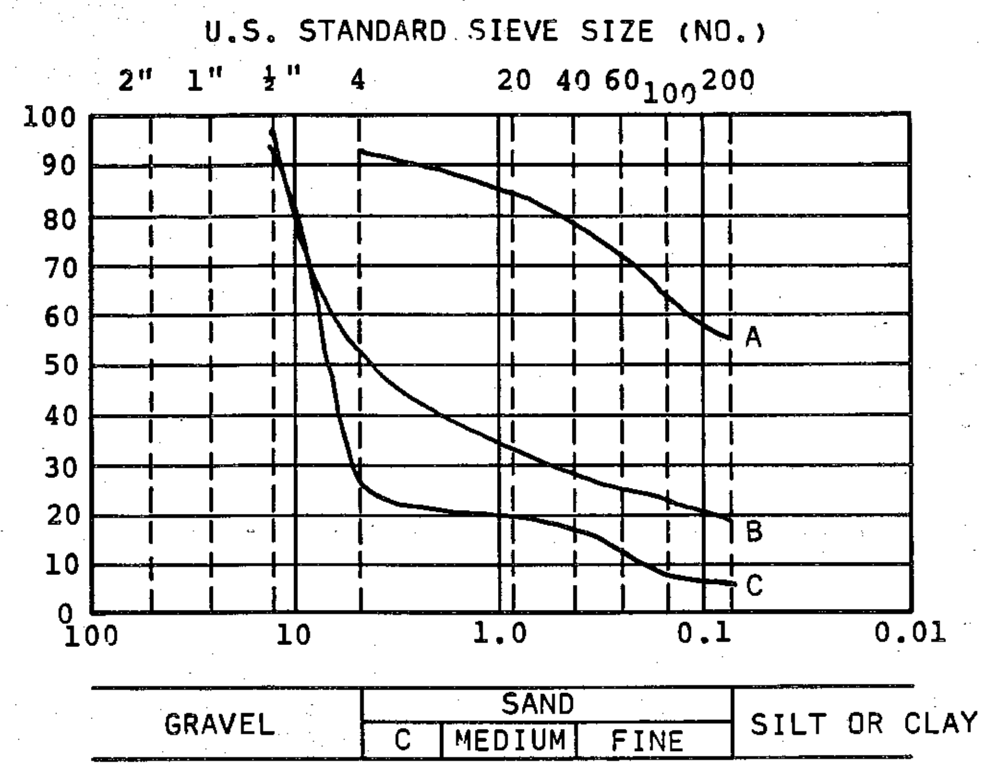
BELLE RIVER PLANT
UNIT 1 & 2

GRAIN SIZE DISTRIBUTION
UPPER AND MIDDLE STRATA

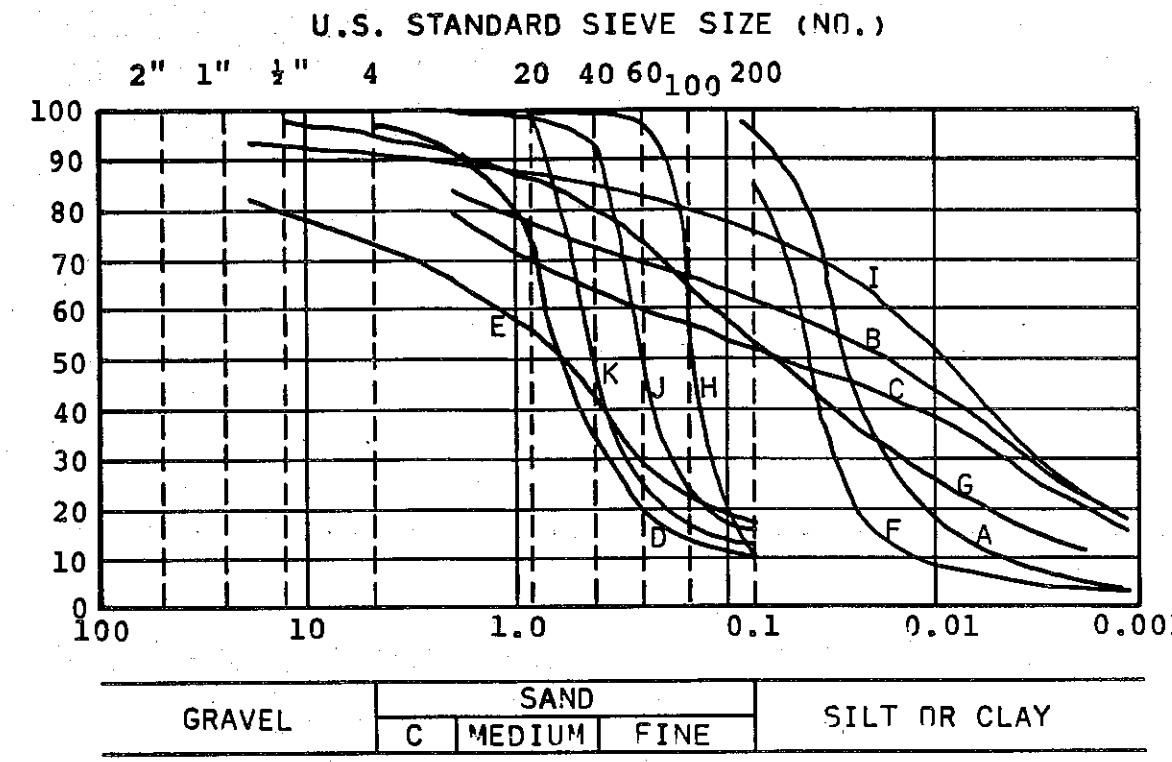
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 21	0



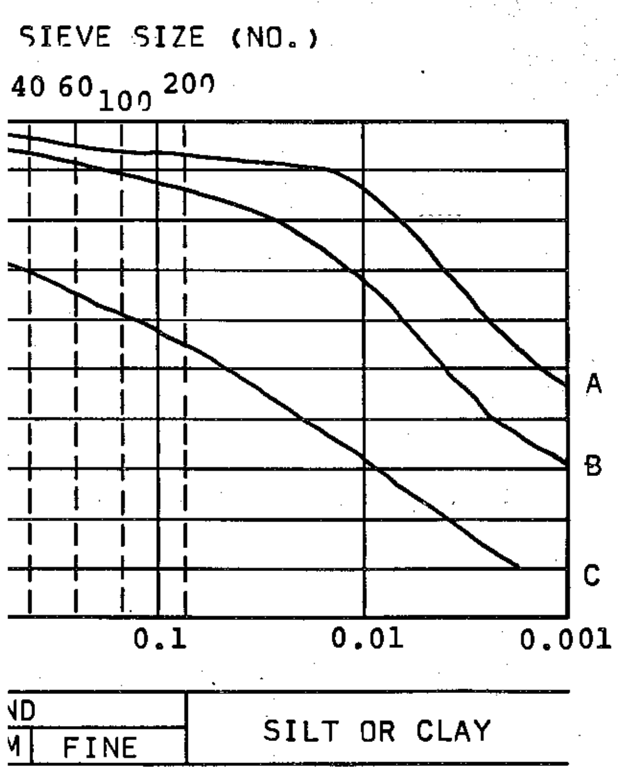
REA EAST OF MAIN PLANT



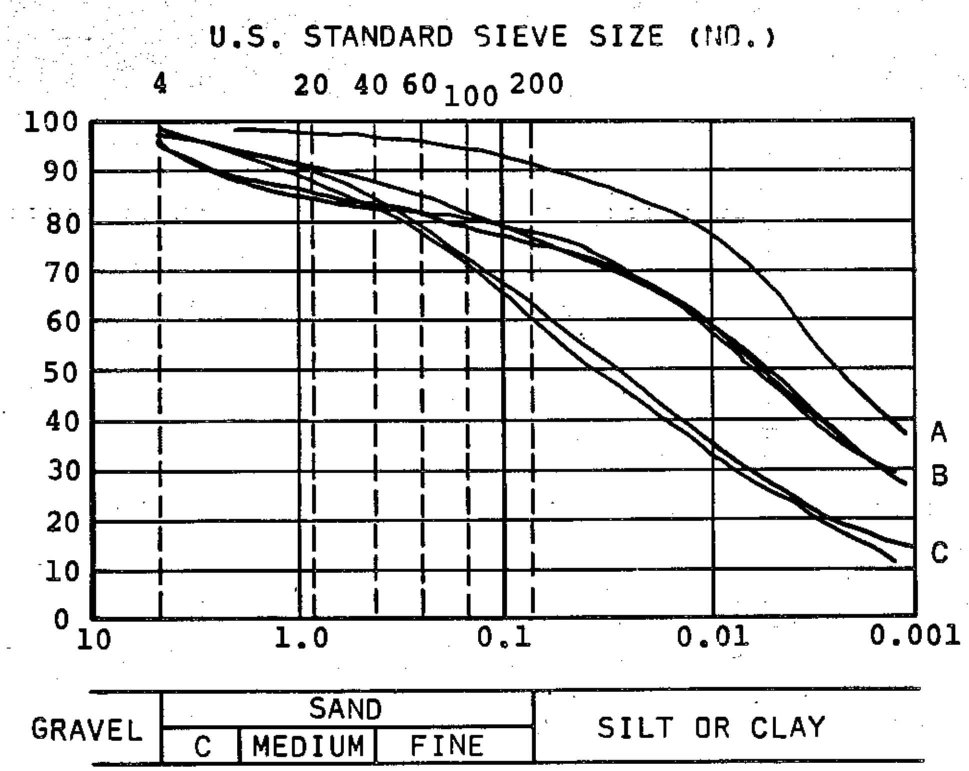
NORTHWEST FLY ASH DISPOSAL AREA



MAIN PLANT AREA



STORAGE AREA



DOCK AREA

MAIN PLANT AREA

	BORING NUMBER	SAMPLE DEPTH (FEET)
A	7 (CL-ML)	130
B	7 (CL-ML)	139
C	10 (CL-ML)	141
D	18 (SM-SW)	104
E	18 (SM)	140
F	22 (CL-ML)	134
G	27 (CL-ML)	69
H	27 (SM-SP)	114
I	30 (CL)	69
J	30 (SM)	99
K	30 (SM)	119

SECONDARY COAL STORAGE AREA
EAST OF MAIN PLANT

	BORING NUMBER	SAMPLE DEPTH (FEET)
A	38 (CL)	54.1
A	38 (CH)	74.0
A	38 (CL)	84.6
A	38 (CL)	114.2
C	38 (SM)	138.5
B	41 (CL-SC)	72.9
A	41 (CL)	101.9
B	41 (GC-SC)	130.7

NORTHWEST FLY ASH DISPOSAL AREA

	BORING NUMBER	SAMPLE DEPTH (FEET)
C	139 (GP)	100
B	141 (GM)	115
A	141 (SM-SC)	145

MAIN COAL STORAGE AREA

	BORING NUMBER	SAMPLE DEPTH (FEET)
A	48 (CL)	118
B	49 (CL)	63
C	187 (CL-ML)	59

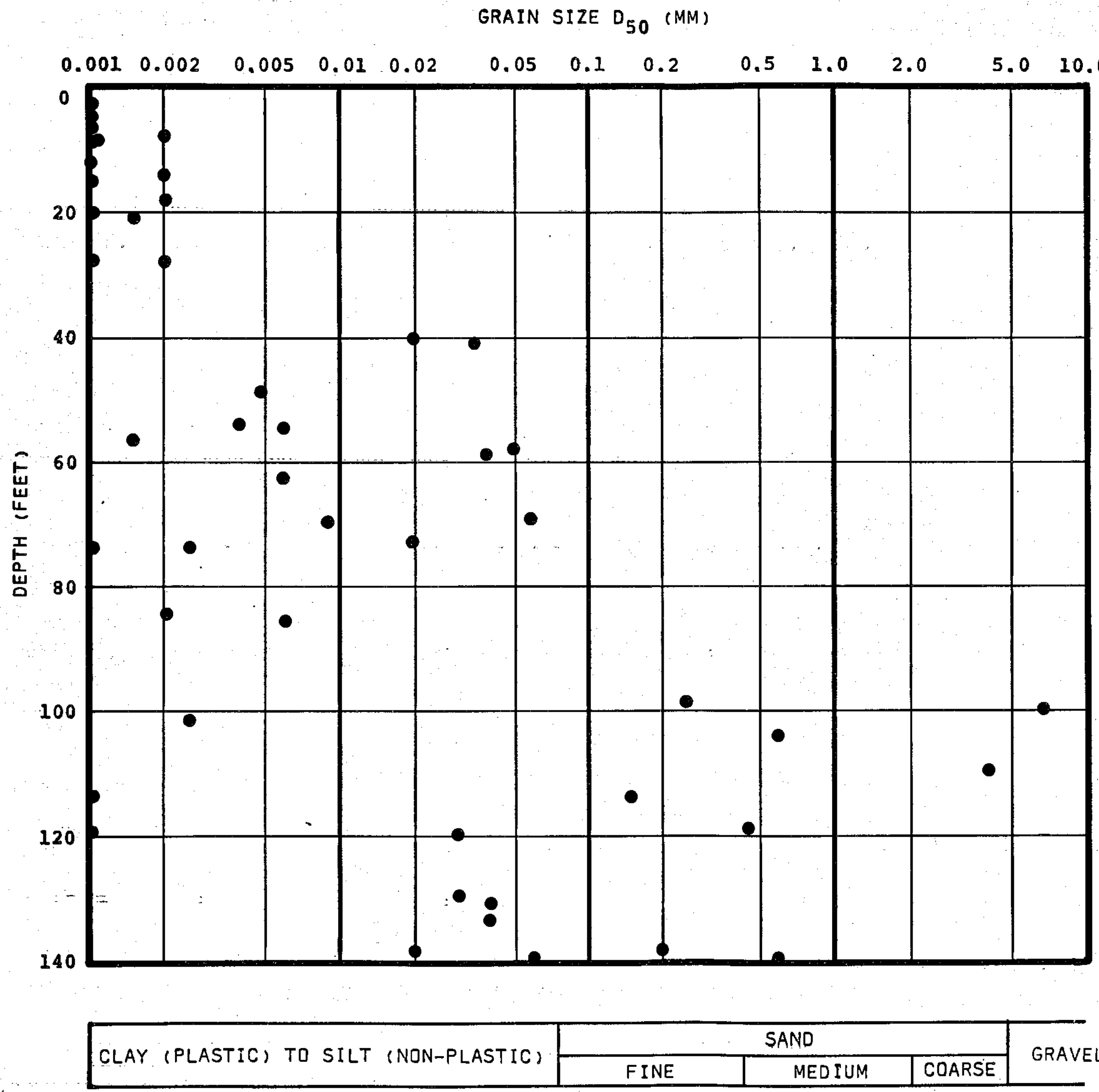
DOCK AREA

	BORING NUMBER	SAMPLE DEPTH (FEET)
C	52 (CL)	58.6
B	54 (CL)	63.5
A	54 (CL)	73.7
B	60 (CL)	56.1
B	60 (CL)	85.6
C	60 (CL)	119.5

NOTES:

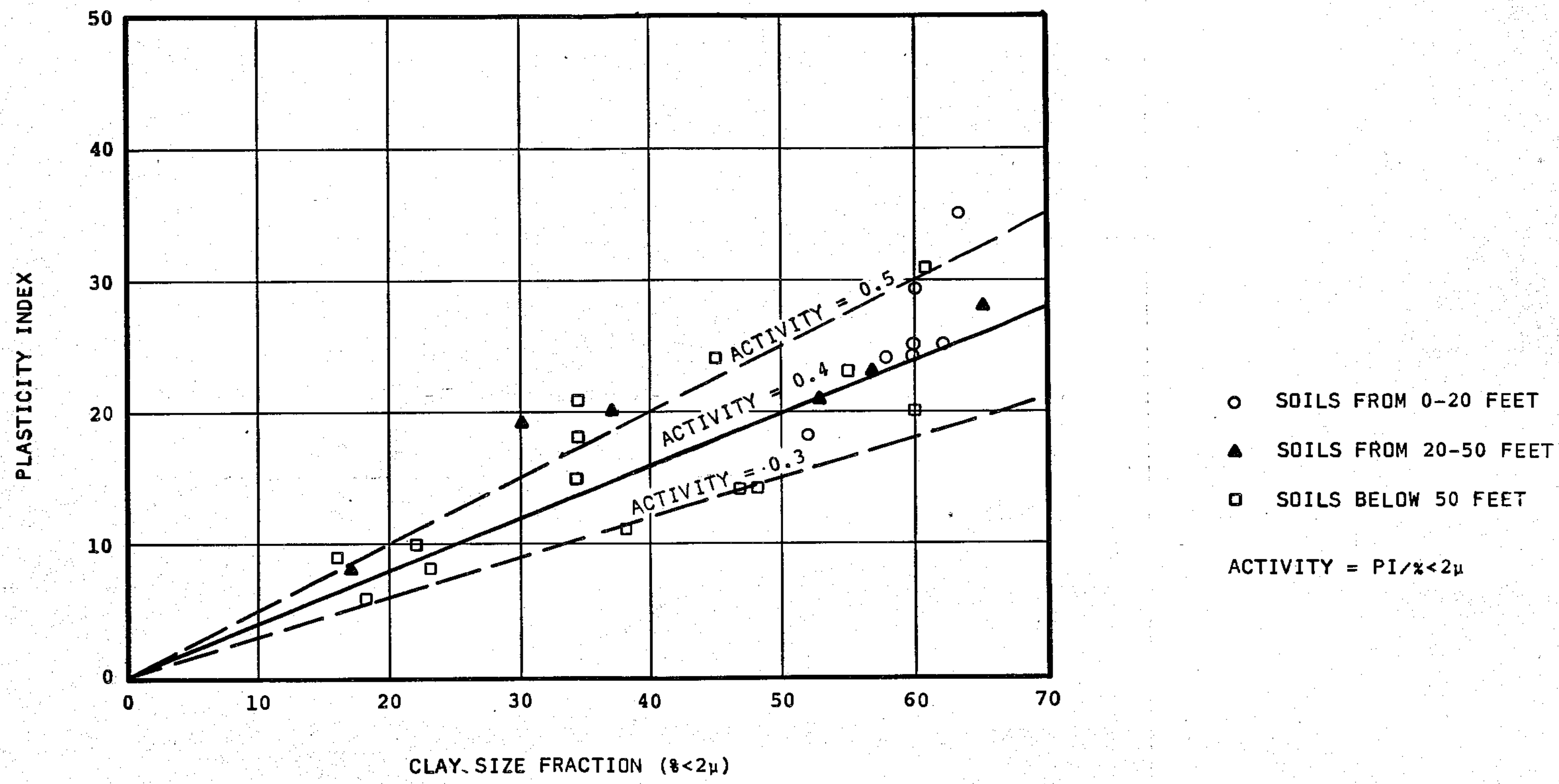
1) ALL SOILS ARE BELOW 50 FEET.
2) SOIL DIVISIONS AS PER UNIFIED SOIL CLASSIFICATION SYSTEM

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
GRAIN SIZE DISTRIBUTION LOWER STRATUM		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 22	0



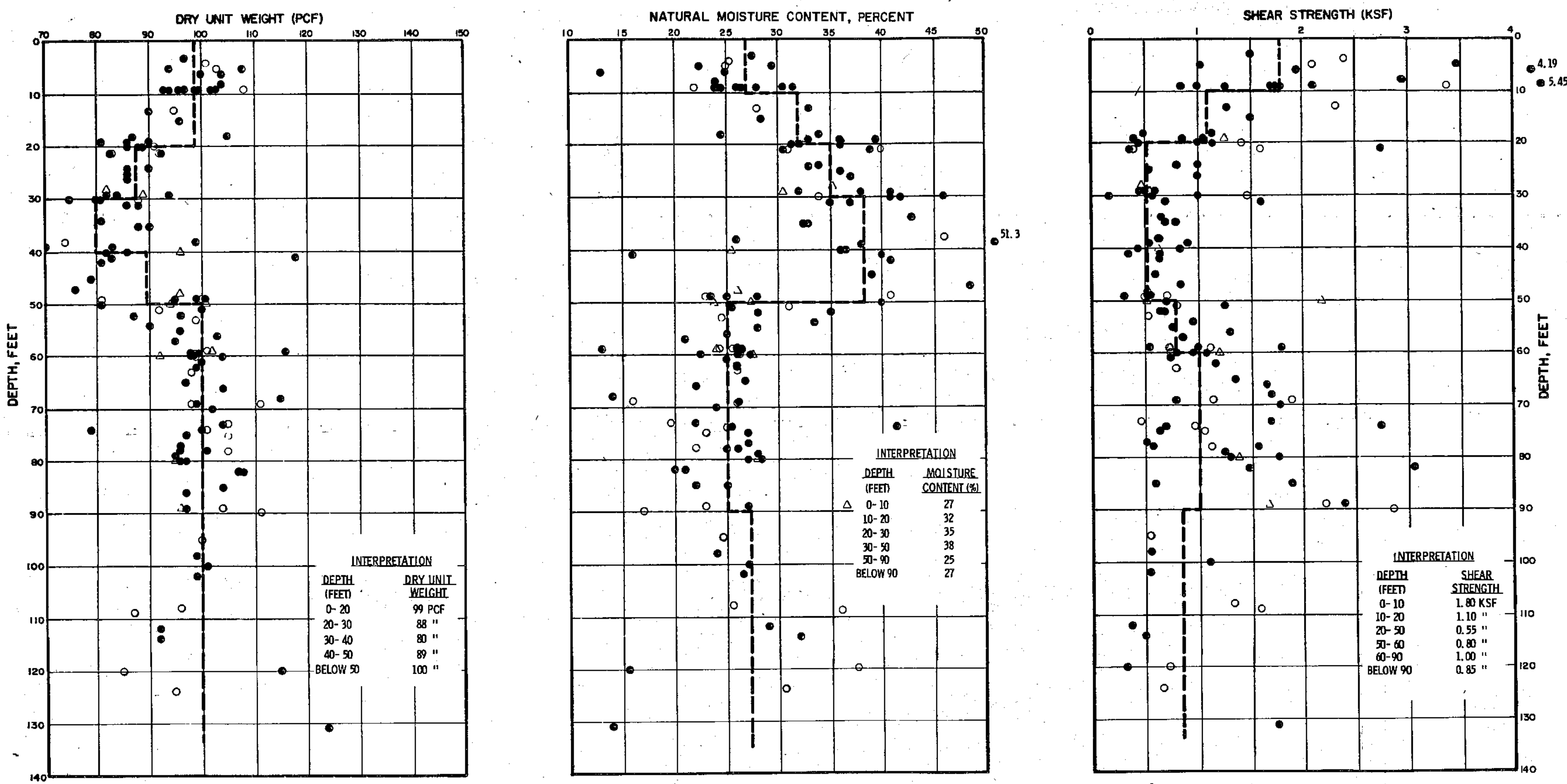
UNIFIED SOIL CLASSIFICATION SYSTEM

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
GRAIN SIZE (D_{50}) vs DEPTH		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 23	0



BECHTEL ANN ARBOR
BELLE RIVER PLANT UNITS 1 & 2
ACTIVITY OF CLAY SOILS

JOB No.	DRAWING No.	REV.
10539	FIGURE 24	C



EXPLANATION

● UNCONFINED COMPRESSION TESTS
○ UNCONSOLIDATED UNDRAINED TESTS
△ LABORATORY VANE SHEAR TESTS

NOTES:

1.) ALL VALUES REPRESENT PEAK STRENGTHS.
2.) DRY UNIT WEIGHT AND NATURAL MOISTURE CONTENT CORRESPOND TO SHEAR STRENGTH TEST RESULTS.

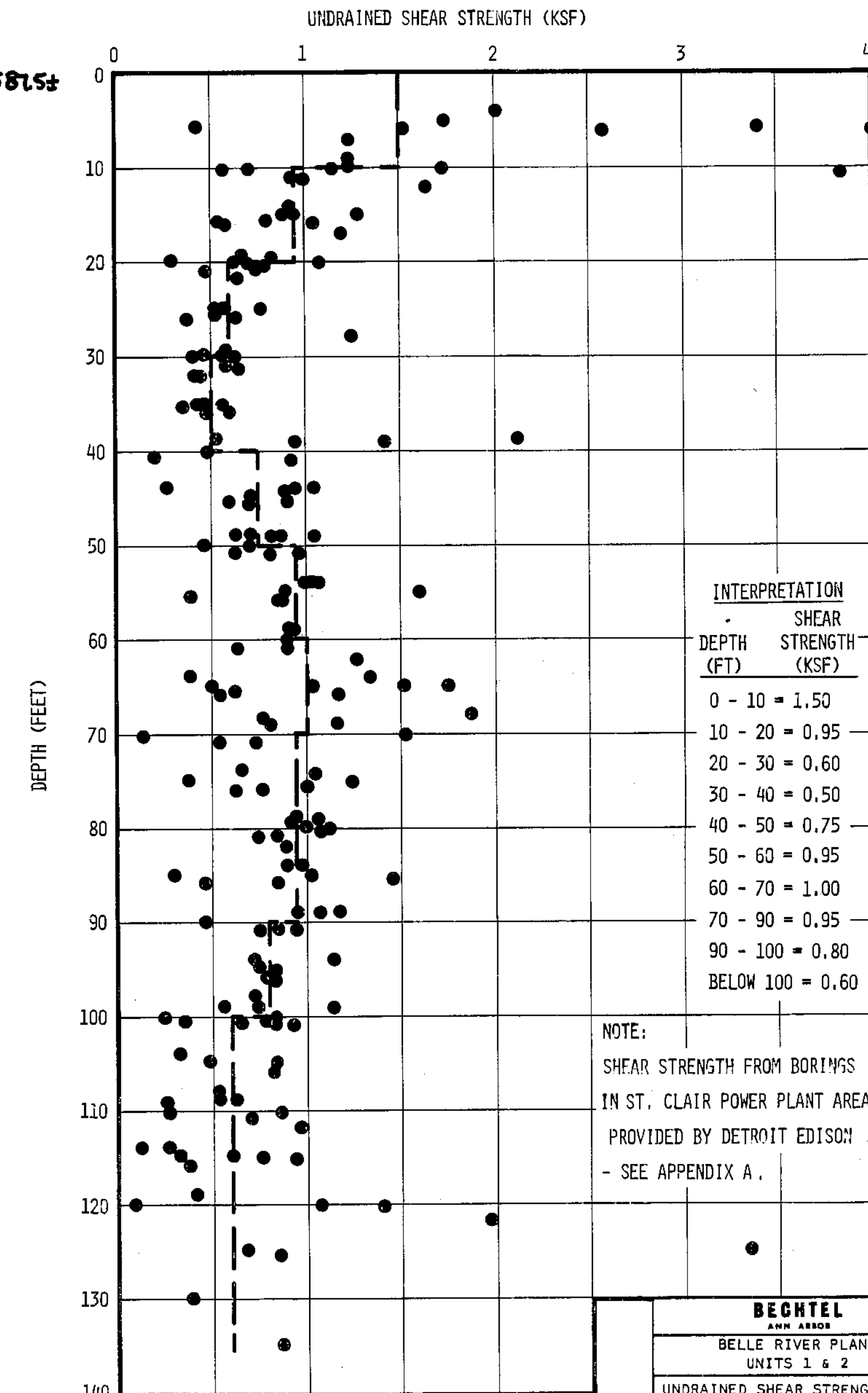
BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

DRY UNIT WEIGHT, NATURAL WATER CONTENT, AND SHEAR STRENGTH VS DEPTH, ENTIRE SITE

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 25	0

5825±

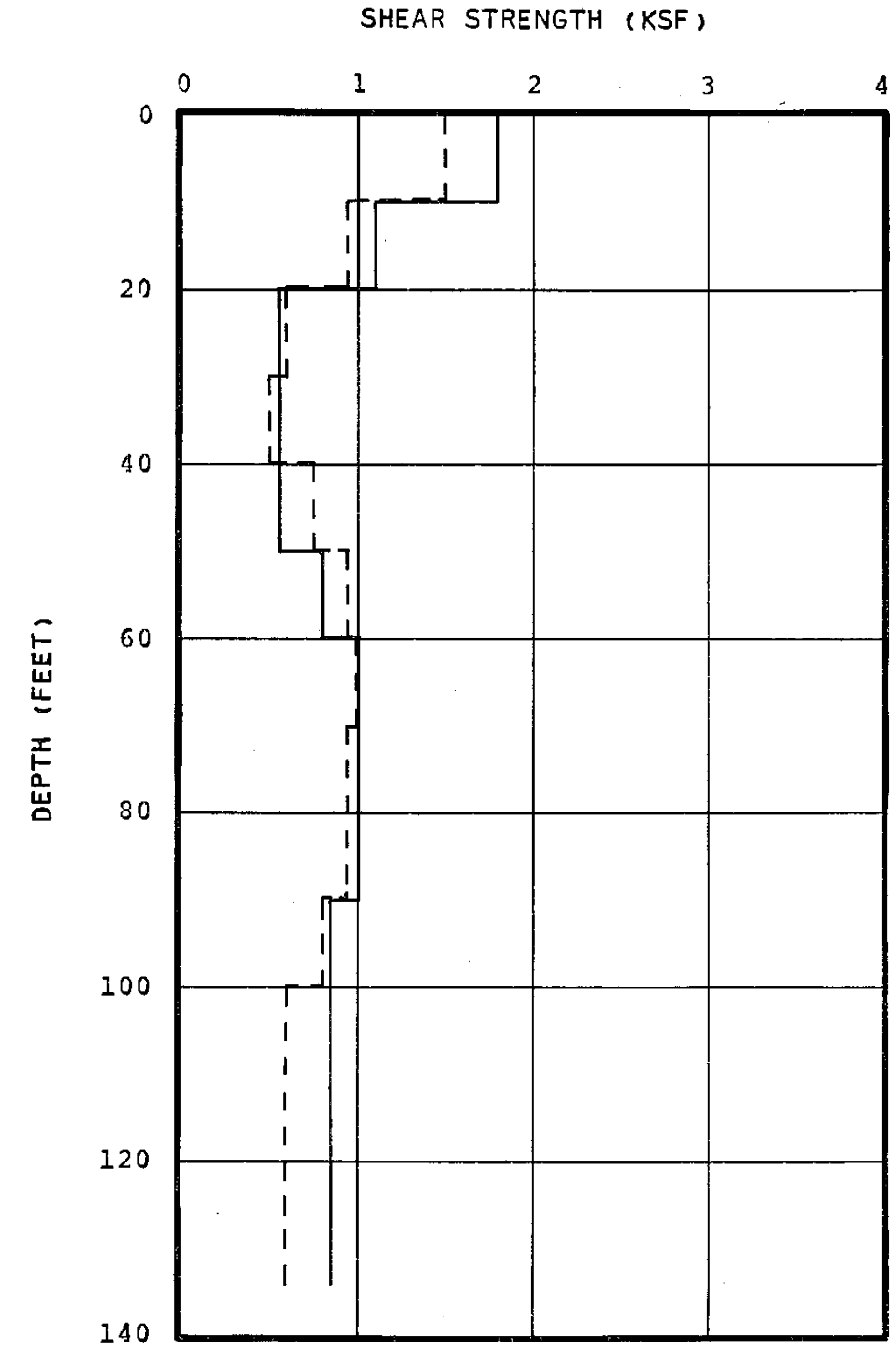


BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNITS 1 & 2

UNDRAINED SHEAR STRENGTH FROM PREVIOUS INVESTIGATIONS

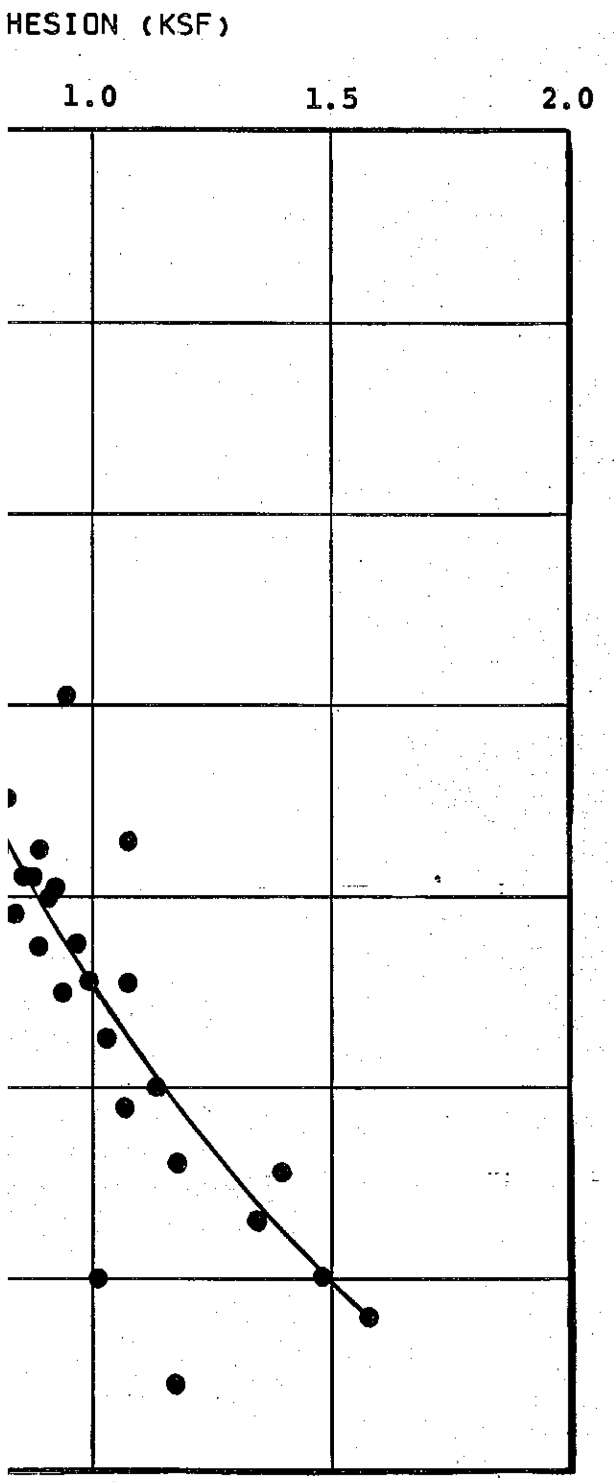
JOB No.	DRAWING No.	REV
10539	FIGURE 26	



HOUSEL UNDRAINED SHEAR STRENGTH DATA (SEE FIG. 26)

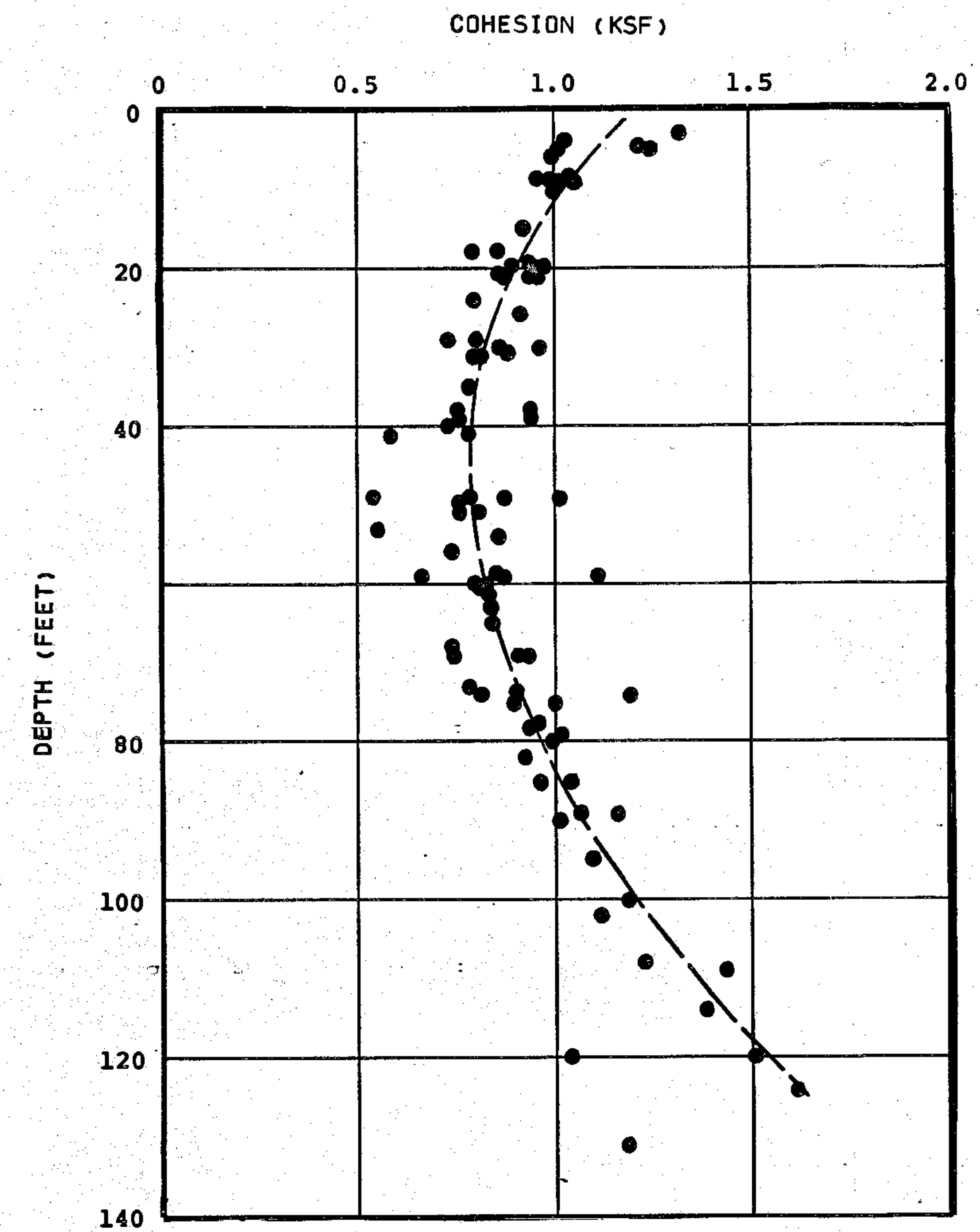
BECHTEL UNDRAINED SHEAR STRENGTH DATA (SEE FIG. 25)

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
COMPARISON OF HOUSEL AND BECHTEL UNDRAINED SHEAR STRENGTH		
JOB No.	DRAWING No.	REV.
10539	FIGURE 27	0



PRESSURE (P_0) WAS SUBSTITUTED
RELATIONSHIP
: PI TO OBTAIN COHESION VALUES.

OLIDATED SOILS ASSUMED



NOTE:

PRECONSOLIDATION PRESSURE P_C (CASAGRANDE'S METHOD) WAS SUBSTITUTED FOR $\overline{P}$ IN THE SKEMPTON RELATIONSHIP $C/\overline{P} = 0.11 + 0.0037 \times PI$ TO OBTAIN COHESION VALUES.

B) PRECONSOLIDATED SOILS ASSUMED

SOIL DATA

DEPTH (FT)	TOTAL UNIT WEIGHT (PCF)	EFFECTIVE UNIT WEIGHT (PCF)
0-20	125	63
20-50	115	53
50+	125	63

NOTE:

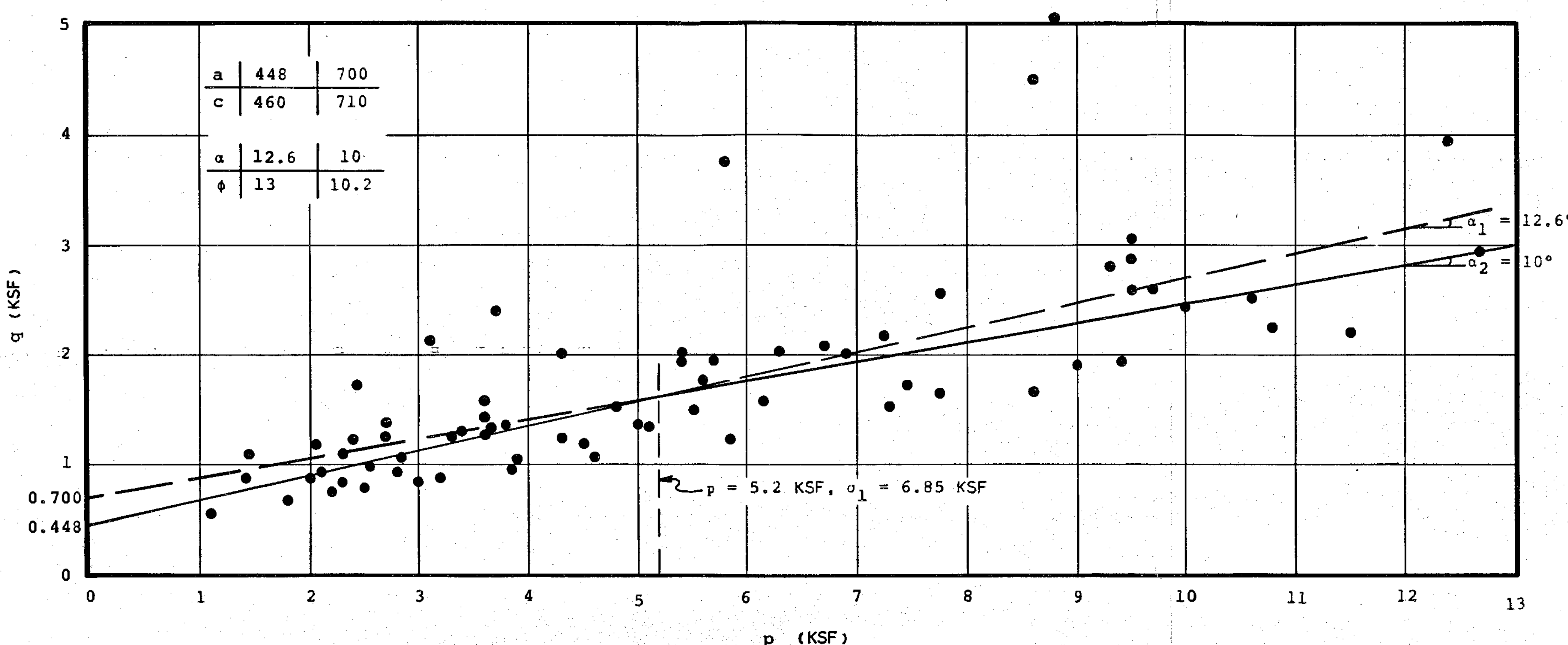
WATER TABLE ASSUMED TO BE AT A DEPTH OF 10 FEET.

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

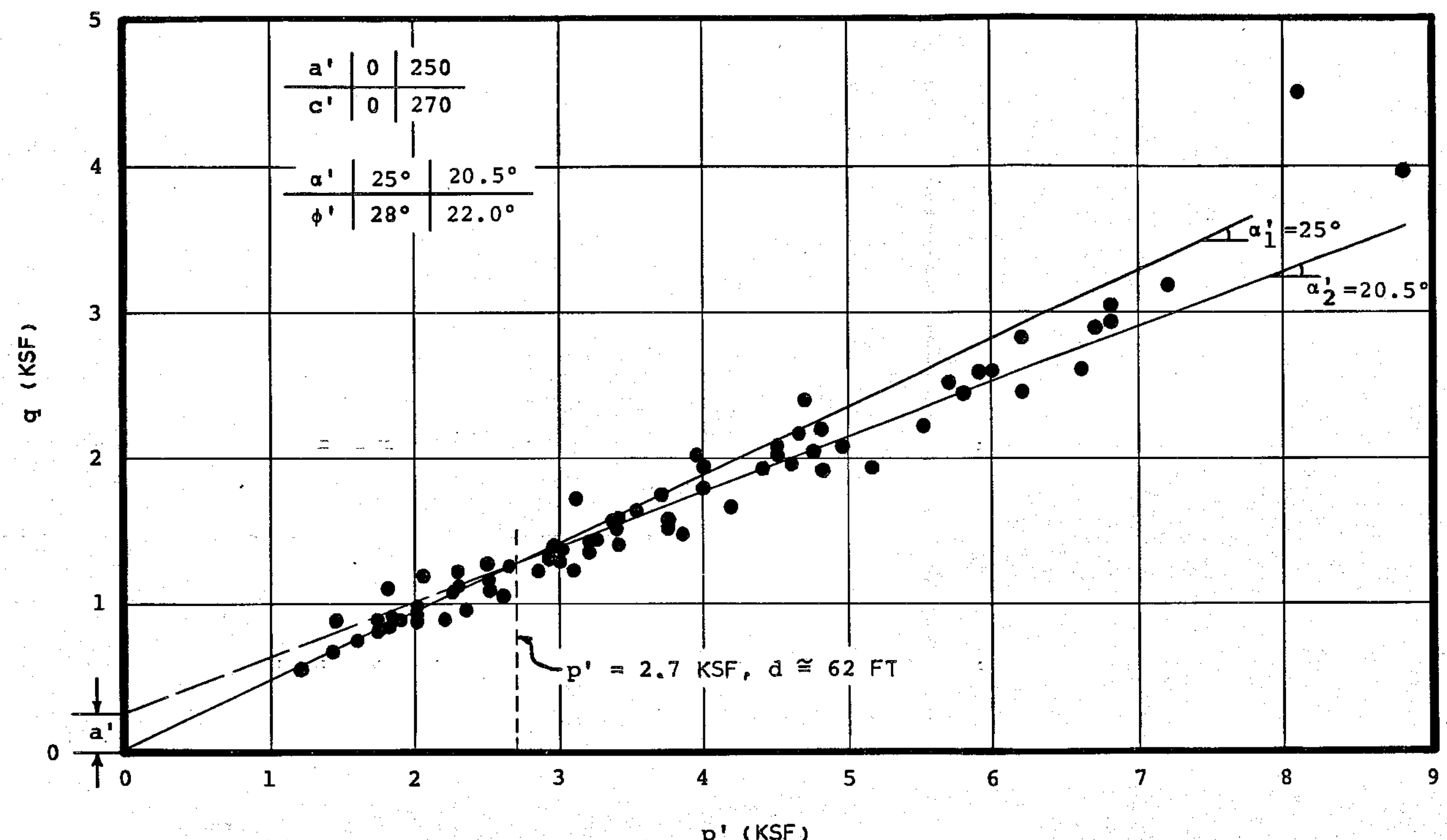
UNDRAINED SHEAR STRENGTH FROM SKEMPTON'S RELATIONSHIP

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 28	0



$$p = \frac{\sigma_1 + \sigma_3}{2} \qquad q = \frac{\sigma_1 - \sigma_3}{2}$$

BECHTEL ANN ARBOR	
BELLE RIVER PLANT UNITS 1 & 2	
p - q DIAGRAM ALL CLAYEY SOILS	
JOB No. 10539	DRAWING No. FIGURE 29	REV A



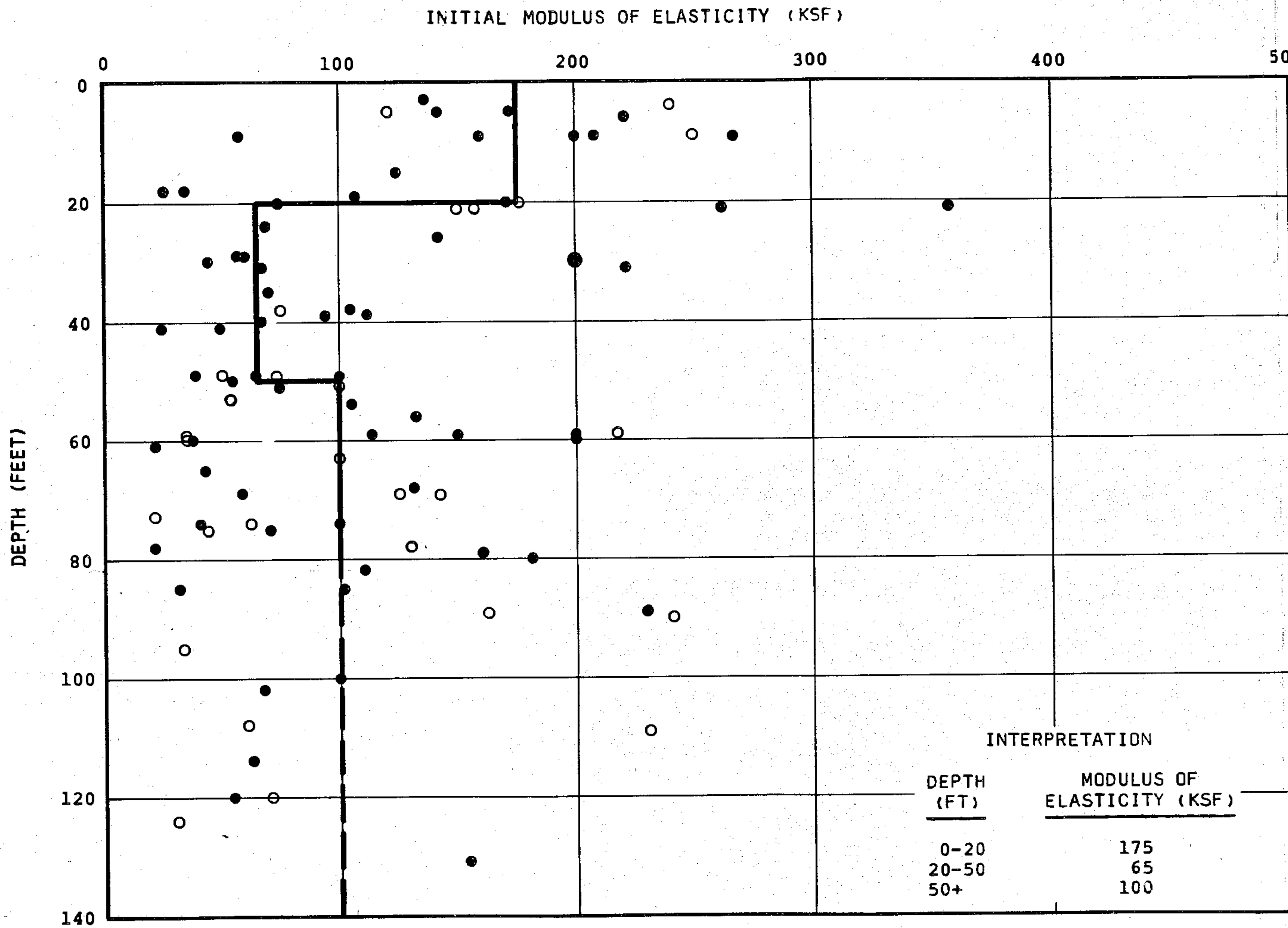
$$p' = \frac{\sigma_1' + \sigma_3'}{2} \qquad q = \frac{\sigma_1' - \sigma_3'}{2}$$

BECHTEL
ANN ARBOR

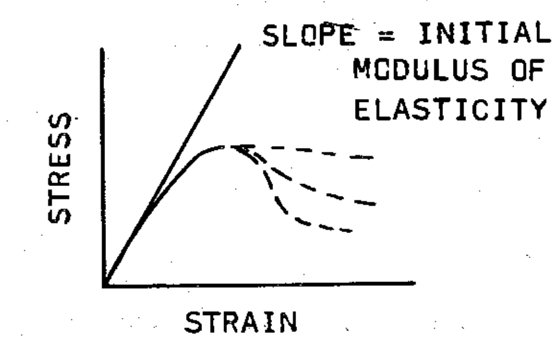
BELLE RIVER PLANT
UNIT 1 & 2

p' - q DIAGRAM
ALL CLAYEY SOILS

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 30	0



DEFINITION



● FROM Qu TEST

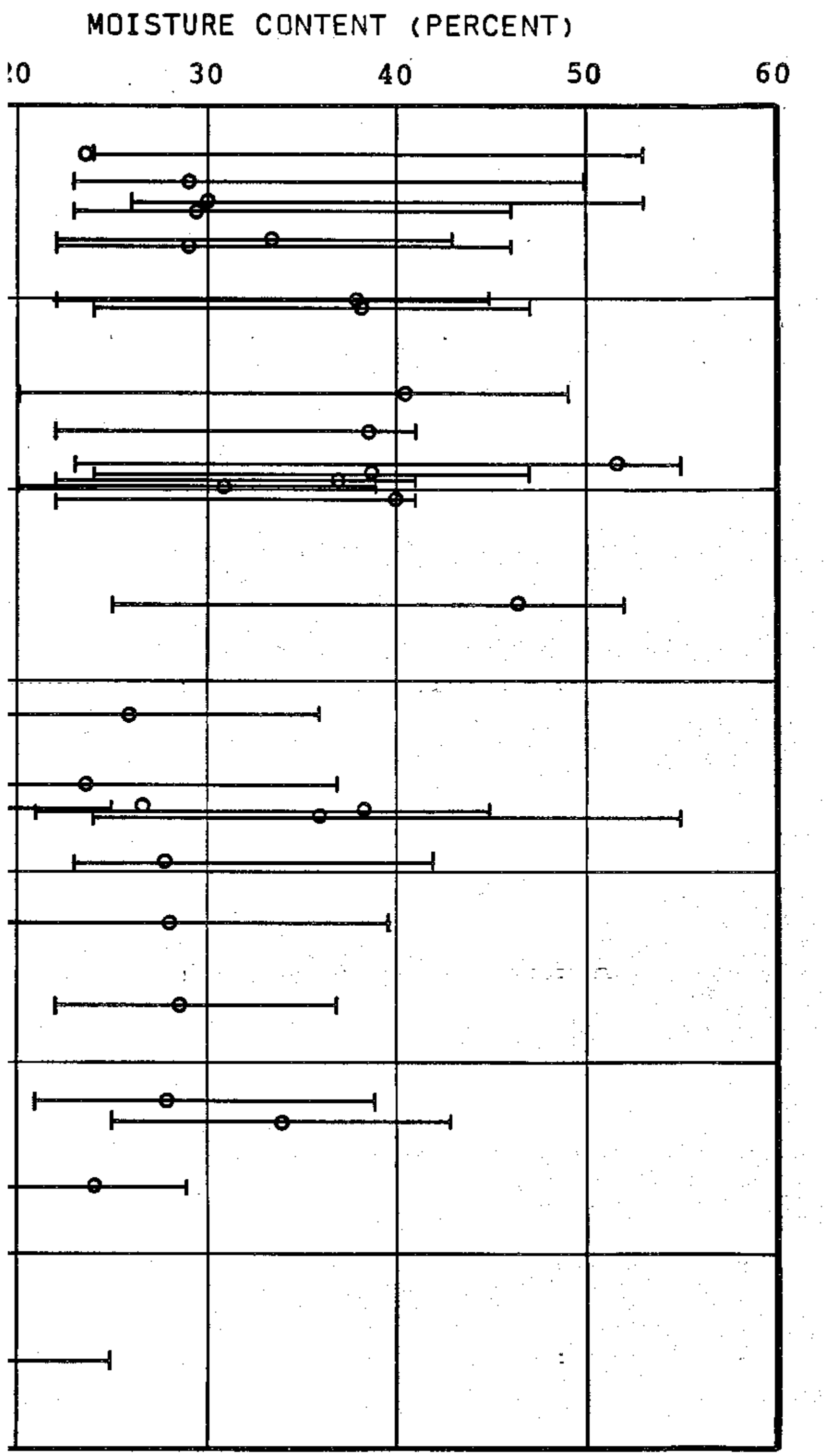
○ FROM UU TEST

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

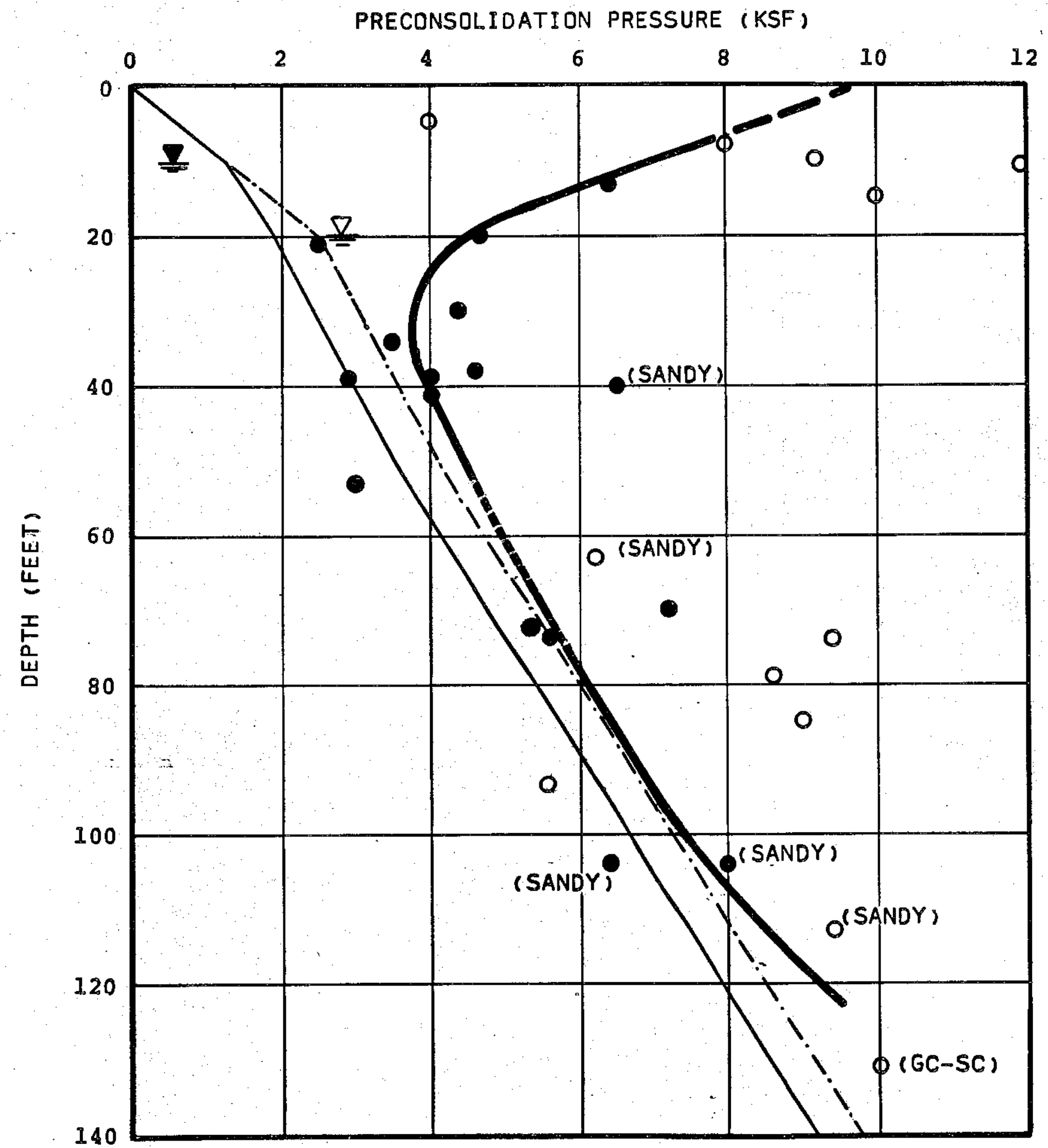
INITIAL MODULUS OF ELASTICITY VS DEPTH

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 31	0



o NATURAL MOISTURE CONTENT

⊣ ATTERBERG LIMITS
LL



● PRECONSOLIDATION PRESSURE FROM CONSOLIDATION TEST (CASAGRANDE PROCEDURE)

O PRECONSOLIDATION PRESSURE FROM CONSOLIDATION TEST (CASAGRANDE PROCEDURE - SAMPLES BELIEVED TO BE RELATIVELY DISTURBED)

SOIL DATA

DEPTH (FT)	TOTAL UNIT WEIGHT (PCF)	EFFECTIVE UNIT WEIGHT (PCF)
0-20	125	63
20-50	115	53
50+	125	63

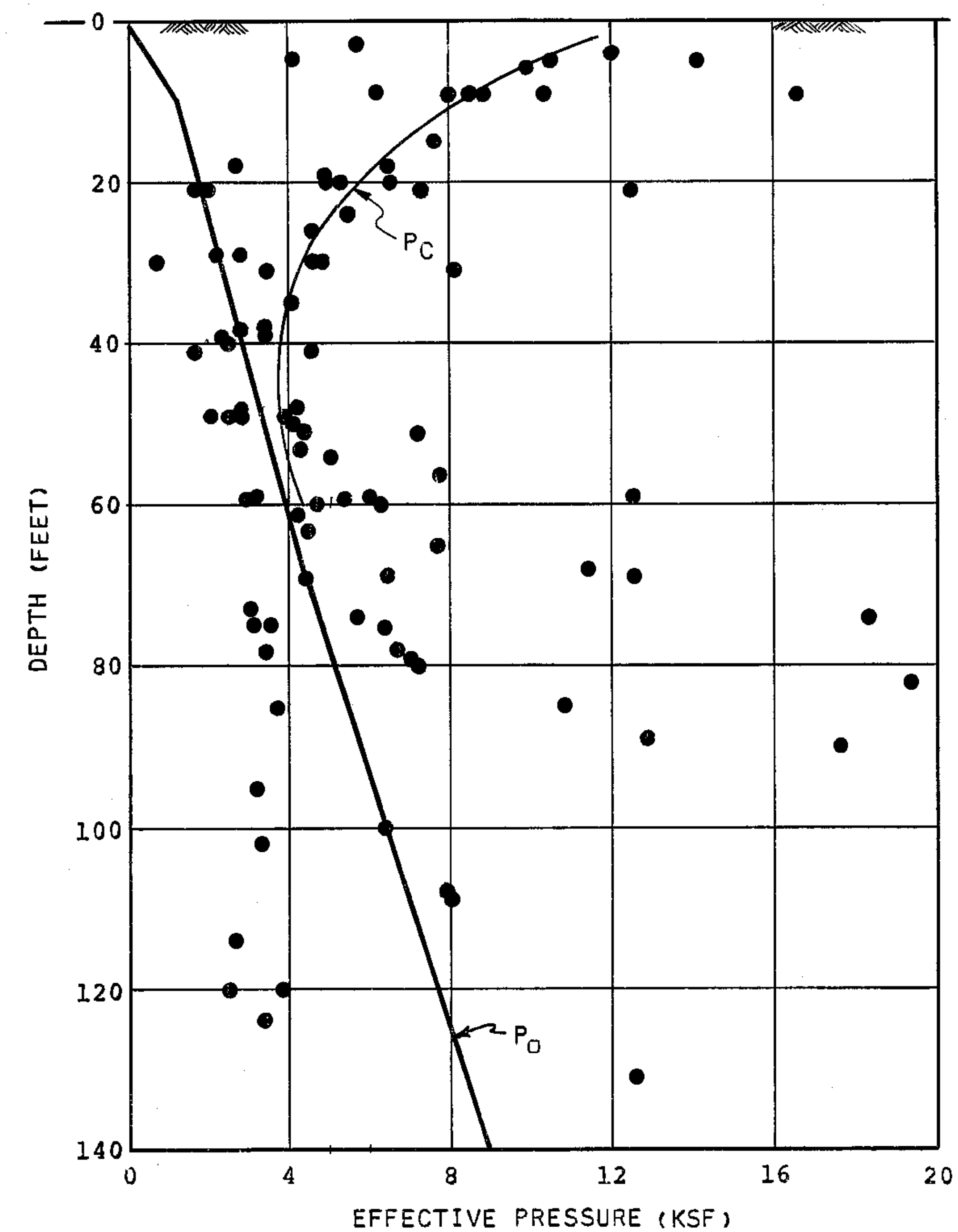
LEGEND

——— EFFECTIVE OVERBURDEN PRESSURE WITH WATER TABLE AT 10 FOOT DEPTH

—·—·— EFFECTIVE OVERBURDEN PRESSURE WITH WATER TABLE AT 20 FOOT DEPTH

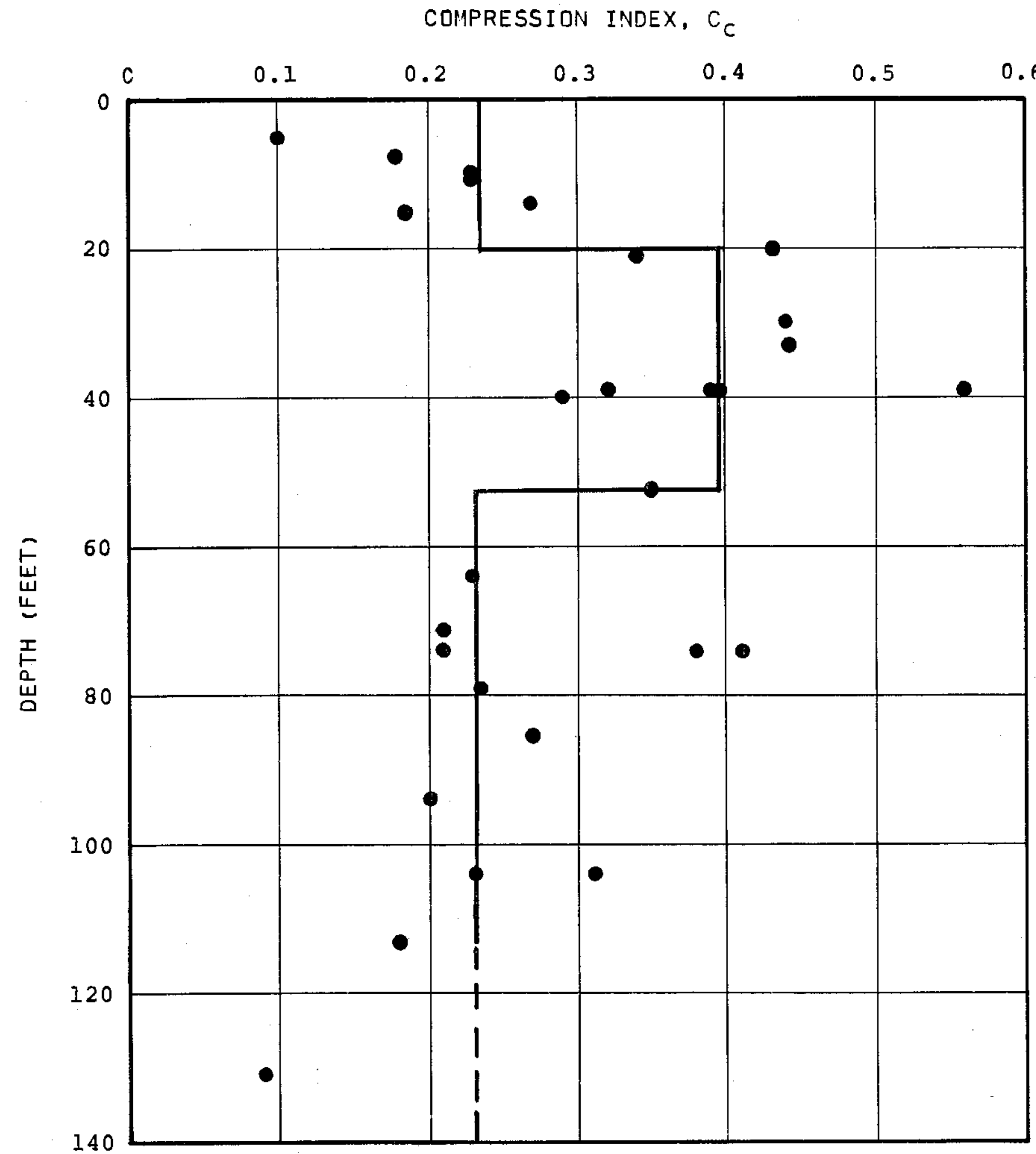
━━━ DESIGN PRECONSOLIDATION PRESSURE

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
PRECONSOLIDATION PRESSURE VS DEPTH		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 32	0



NOTE: COHESION (C) FROM UU & QU TESTS SUBSTITUTED FOR "C" IN SKEMPTON'S RELATIONSHIP $C/\bar{P} = 0.11 + .0037 \times PI$.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
P_C OBTAINED FROM SKEMPTON'S RELATIONSHIP		
JOB No.	DRAWING No.	REV.
10539	FIGURE 33	0

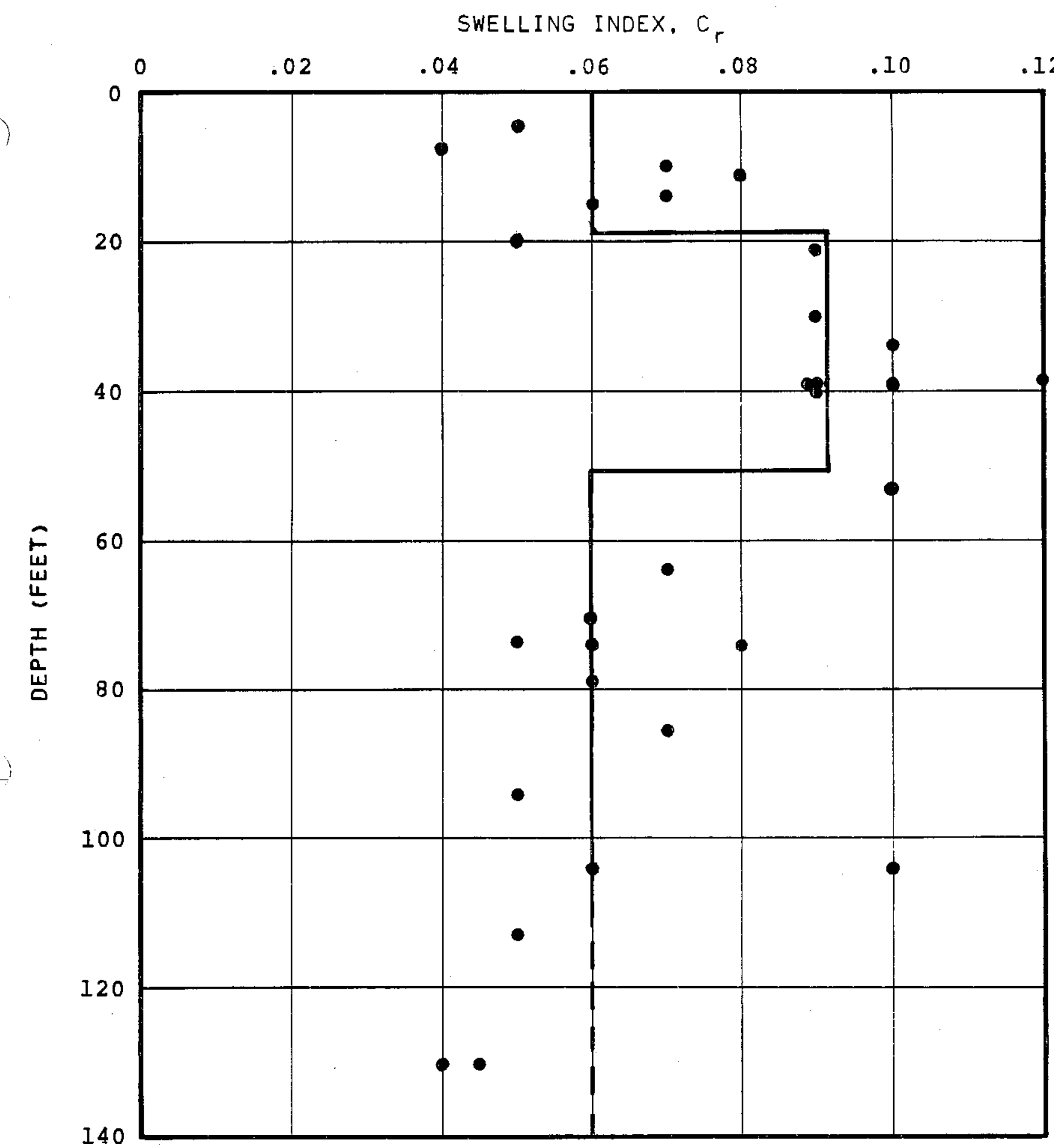


BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNITS 1 & 2

COMPRESSION INDEX VS DEPTH

JOB No.	DRAWING No.	REV
10539	FIGURE 34	B

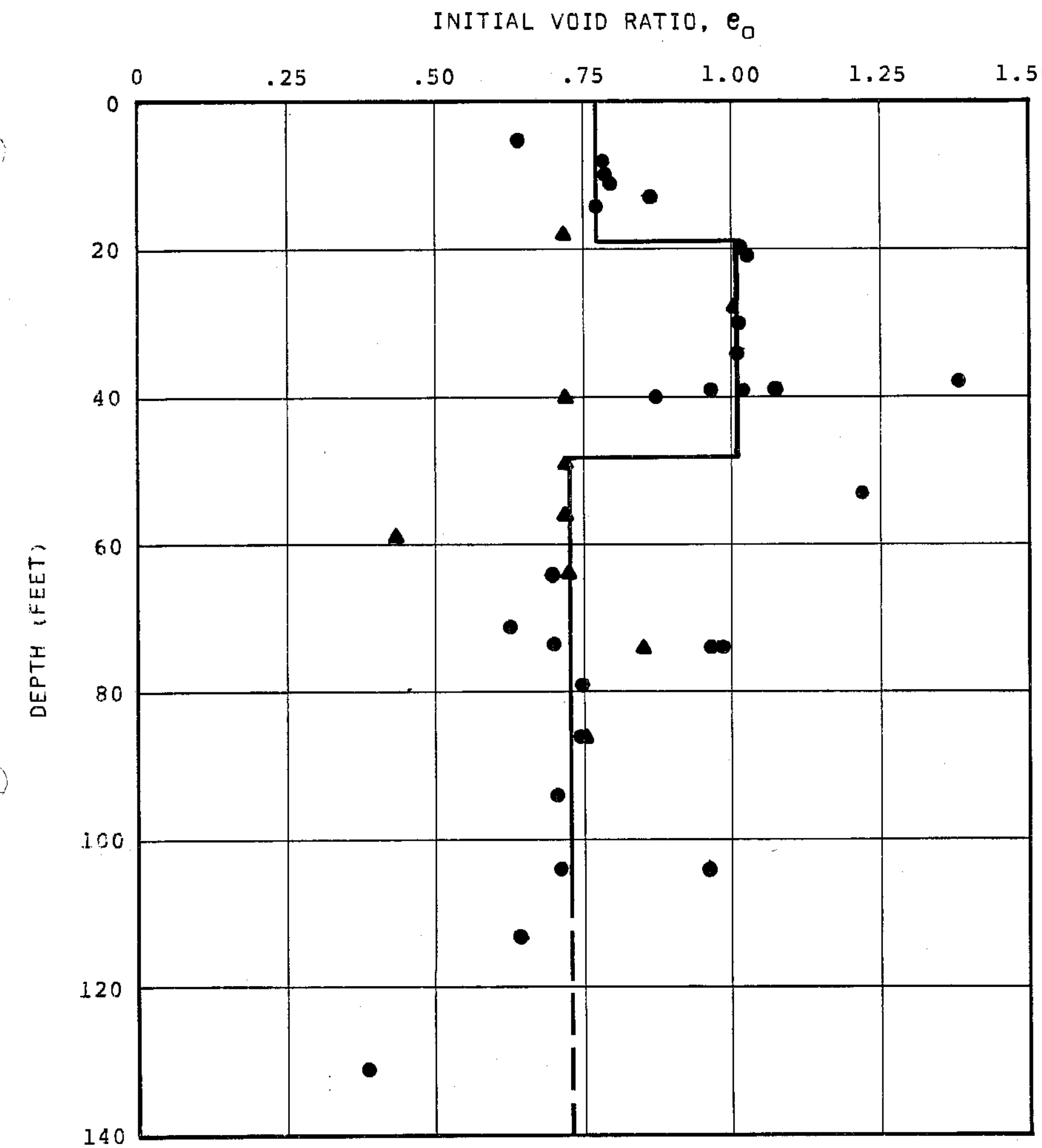


BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNITS 1 & 2

SWELLING INDEX vs DEPTH

JOB No.	DRAWING No.	REV.
10539	FIGURE 35	B



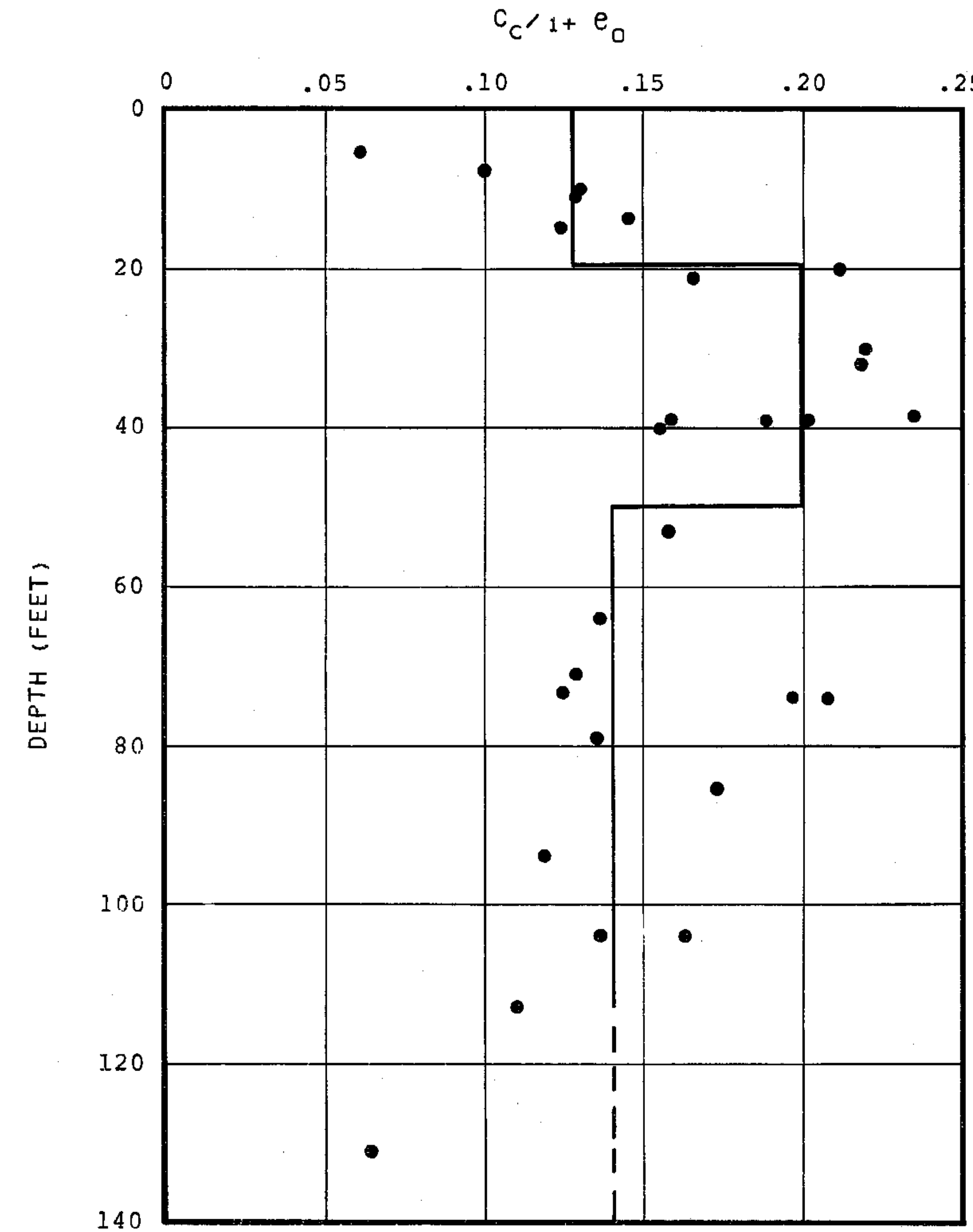
LEGEND

● FROM CONSOLIDATION TEST RESULTS

▲ FROM PERMEABILITY TEST RESULTS

BECHTEL ANN ARBOR
BELLE RIVER PLANT UNITS 1 & 2
INITIAL VOID RATIO VS DEPTH

JOB No.	DRAWING No.	REV.
10539	FIGURE 36	B

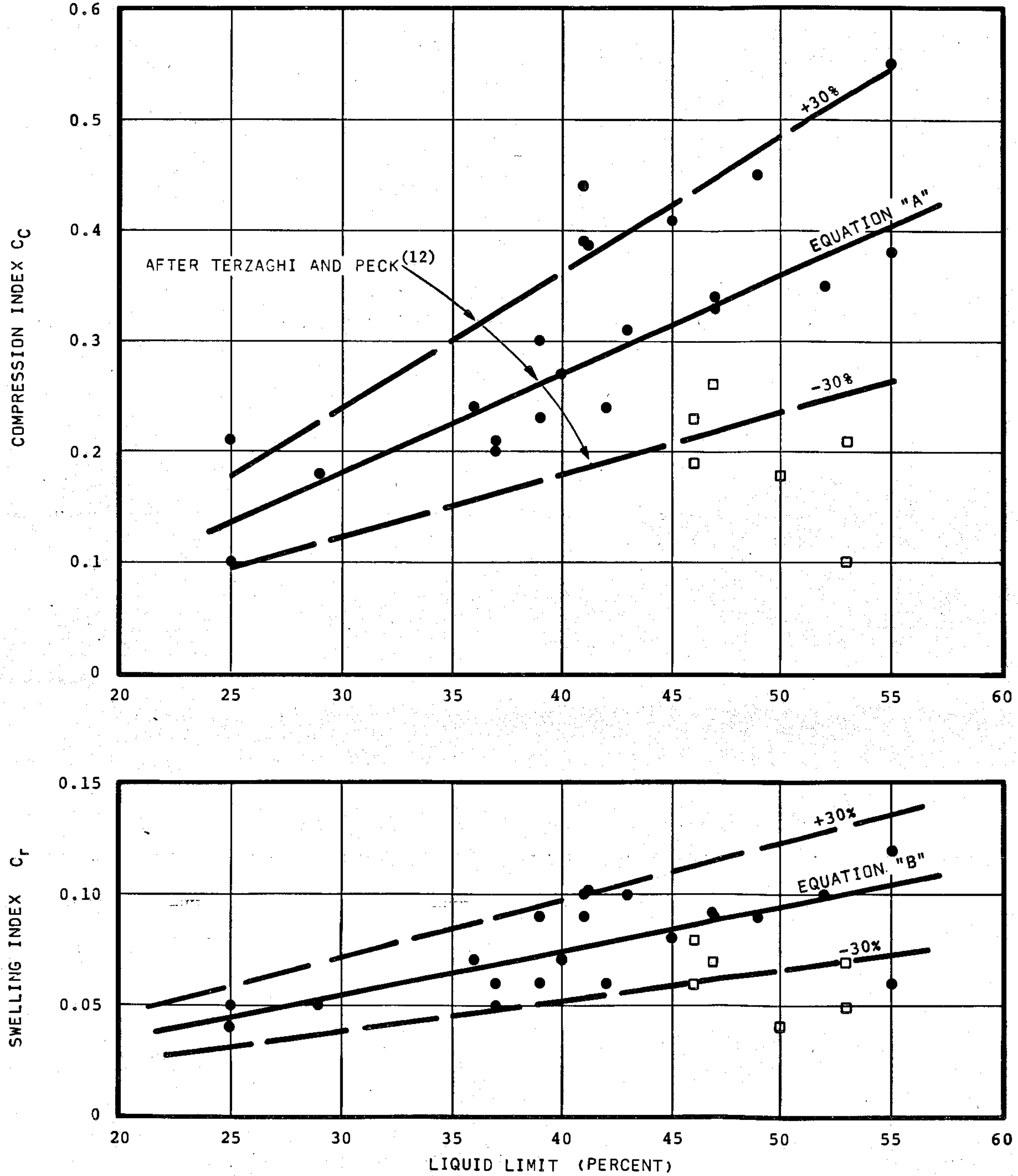


BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNITS 1 & 2

SETTLEMENT PARAMETER
$C_c/1+e_o$ VS DEPTH

JOB No.	DRAWING No.	REV.
10539	FIGURE 37	B



NOTES:

□ UPPER STRATUM (0-20 FEET) OVERCONSOLIDATION RATIO GREATER THAN 4.

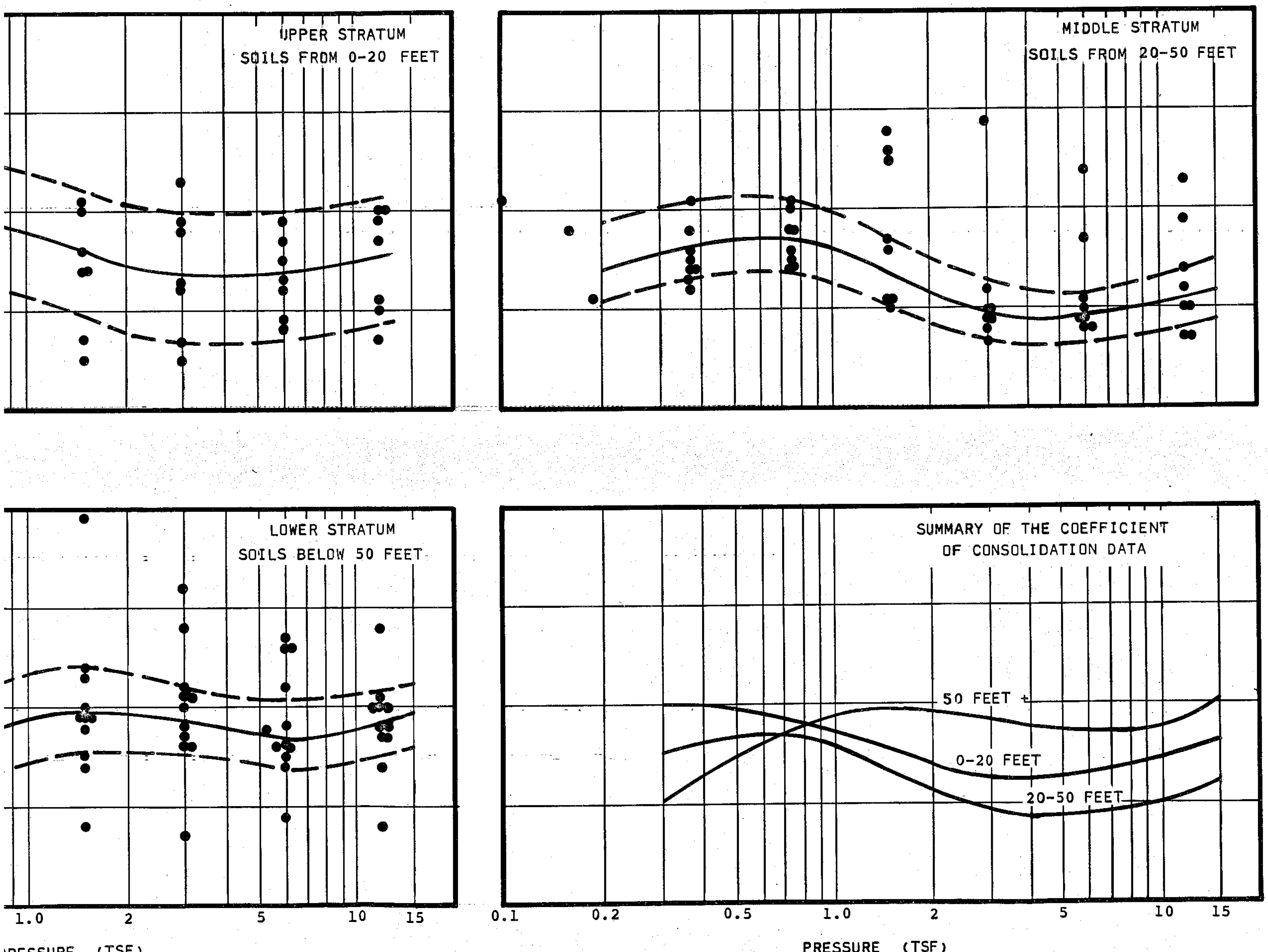
● MIDDLE AND LOWER STRATA (BELOW 20 FEET) OVERCONSOLIDATION RATIO LESS THAN 2.

EXPLANATION

EQUATION "A" — COMPRESSION INDEX
$C_c = 0.009(LL-10)$

EQUATION "B" — SWELLING INDEX
$C_r = 0.002(LL-2.5)$

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
LIQUID LIMIT vs COMPRESSION AND SWELLING INDICIES		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 38	0



NOTE:

COEFFICIENT OF CONSOLIDATION BASED ON THE SQUARE ROOT OF TIME METHOD.

EXPLANATION:

— — — RANGE OF VALUES

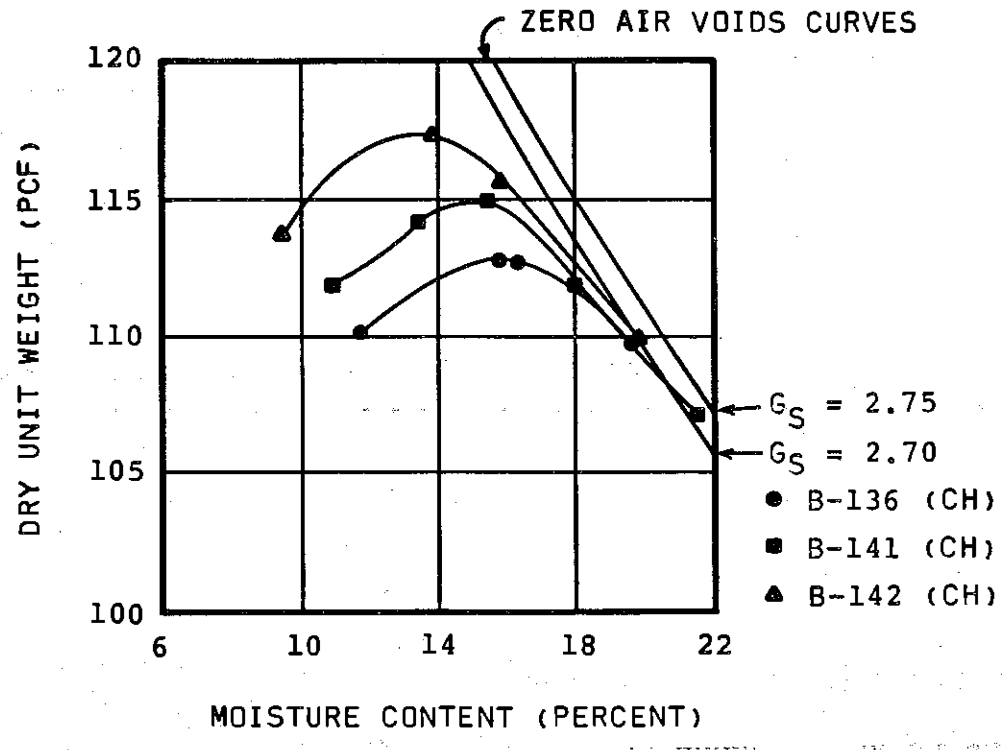
——— DESIGN CURVE

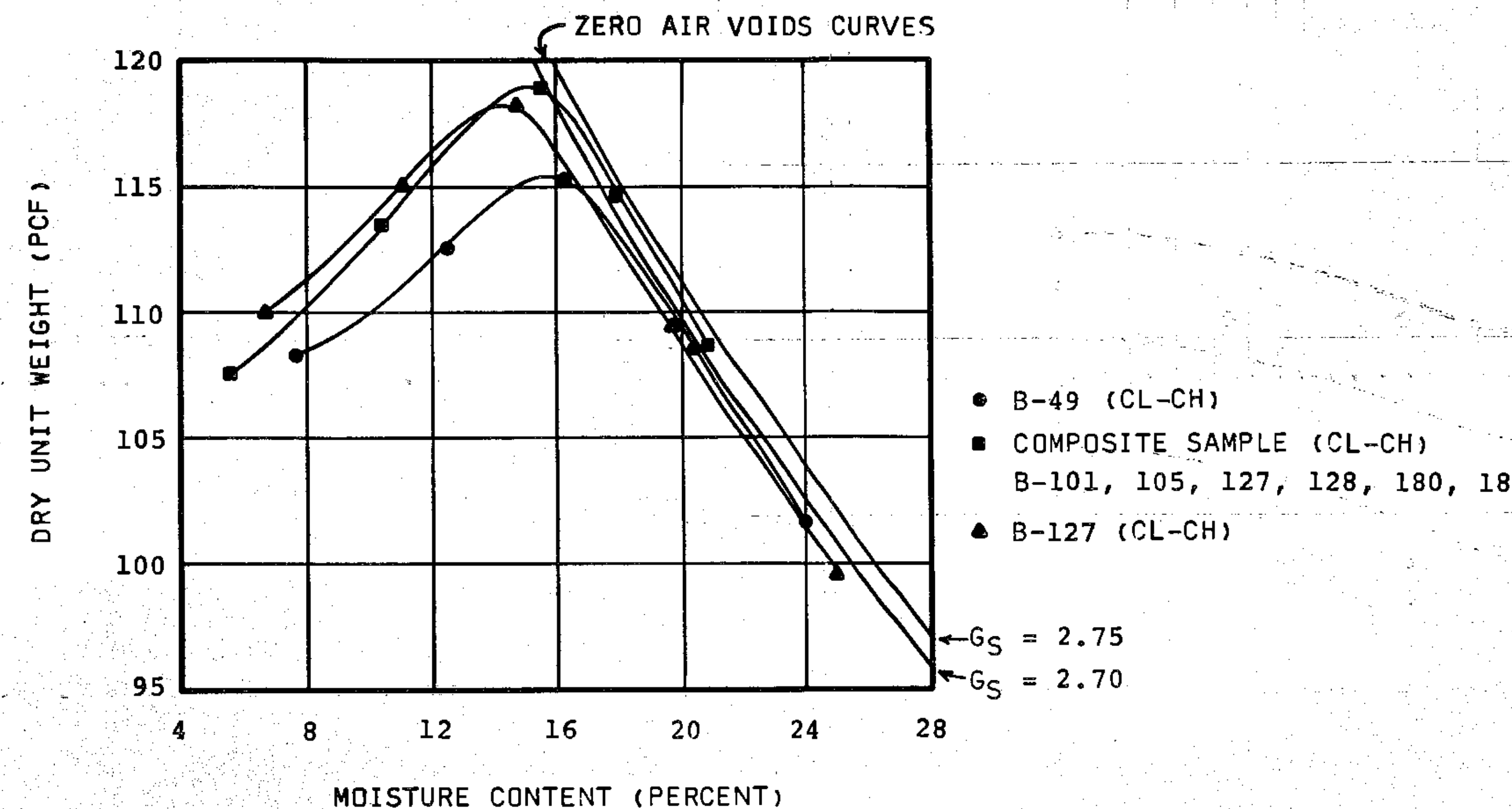
BECHTEL
ANN ARBOR

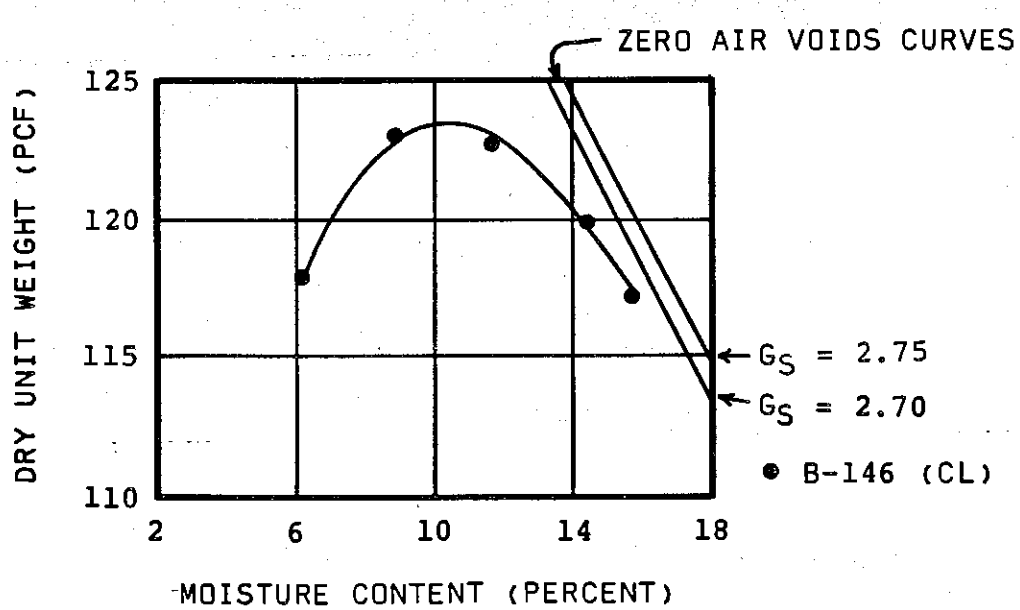
BELLE RIVER PLANT
UNIT 1 & 2

COEFFICIENT OF CONSOLIDATION
VS
PRESSURE

JOB NO.	DRAWING NO.	REV.
10539	FIGURE 39	0







NOTES:

1) ALL TESTS WERE MADE ACCORDING TO ASTM D-1557 METHOD C.

2) THE ZERO AIR VOIDS CURVES HAVE BEEN DRAWN FOR ASSUMED SPECIFIC GRAVITY (G_S) OF 2.70 AND 2.75.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
SUMMARY OF COMPACTION TESTS UPPER STRATA SOILS		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 40	O

Appendix A

P. O. Box 619
Ann Arbor, Michigan 48107
April 5, 1966

Mr. Joseph Funston
The Detroit Edison Company
Room 604 S.B.
2000 Second Avenue
Detroit 26, Michigan

Re: Soil Investigation at the St. Clair Power Plant

Dear Mr. Funston:

Enclosed you will find two sets of the results of the soil investigation made in connection with the extension of Unit No. 7 and the yard's conveyor area.

Each set includes the individual boring log profile of the 1965 borings (22, 25, and 27), followed by two Composite Subsoil Analysis Profiles. One composite is for the Power House Area. Here, superimposed on the composite chart of the 1965 borings, are both the transverse and compression shearing resistances, together with the ASTM standard penetration values from the 1950 borings. Similarly, the soil investigation results from the 1950 borings (13, 14, 15, and 16) are superimposed on the second composite for the yard's conveyor area. Shown on these two composites are three averages for the shear and penetration values. Dotted lines represent the 1965 borings, red lines the 1950 borings, and heavy lines the average of all borings.

As seen on the two composites, a comparison of the soil resistances of the soil strata encountered between the 1950 and 1965 borings is rather clear. However, two tables were prepared to facilitate reference to such comparison. In general, the soil resistances measured in the 1965 borings are lower than those of the 1950 borings, with few exceptions occurring at the lower strata. However, the averages from all borings which are recommended as design values, are closer to the 1965 borings.

It should not be overlooked that the shear values from the 1965 borings are available only from Borings 22 and 25 for one area, and only

Boring 27 for the other area. For this reason, only few values were available in each stratum, and the 1965 average alone should not be considered as representative of the area involved. Because more penetration values are available from all of the 1965 borings, the averages are now more representative and closer to the averages of both the 1950 and 1965 borings. A more detailed report of this investigation will be prepared if desired.

Very truly yours,

Georges Selim
For W. S. Housel

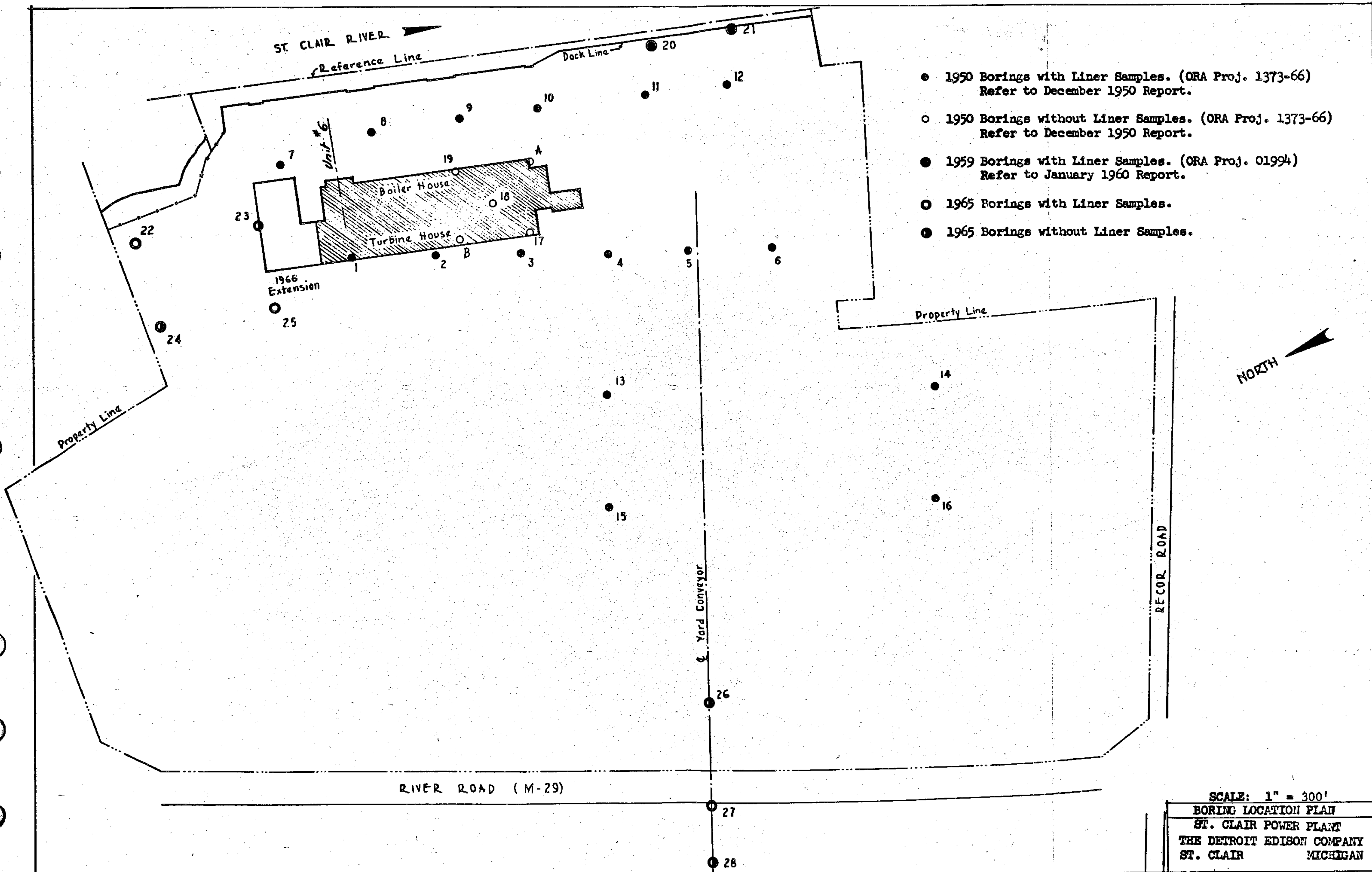
GS:kd
Enclosures

cc: Mr. Robert A. Briggs

SOIL INVESTIGATION AT

ST. CLAIR POWER PLANT

THE DETROIT EDISON COMPANY

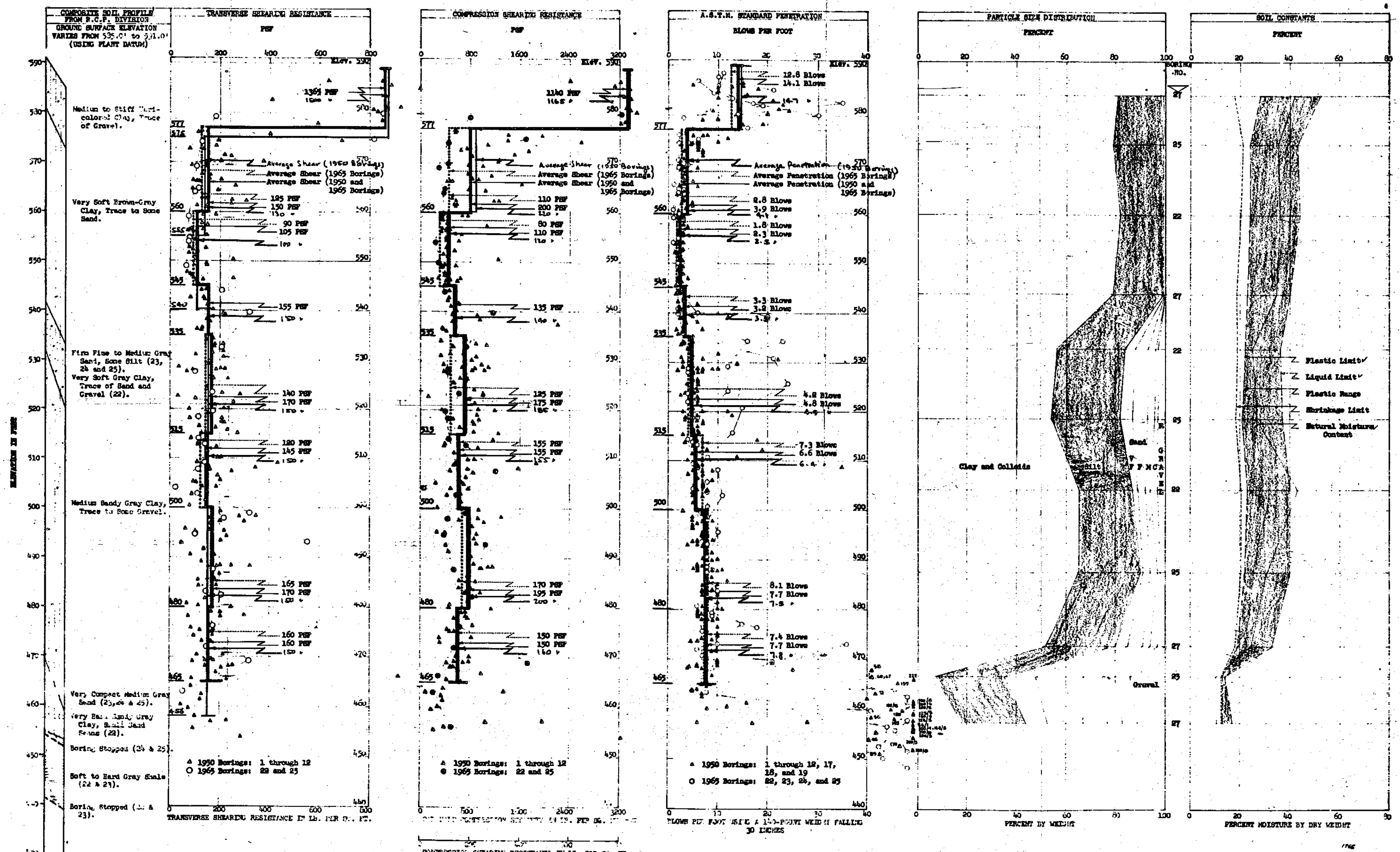

ST. CLAIR RIVER
Reference Line
Dock Line
Unit #6
Boiler House
Turbine House
1966 Extension
Property Line
Property Line
NORTH
Yard Conveyor
RECOR ROAD
RIVER ROAD (M-29)
1950 Borings with Liner Samples. (ORA Proj. 1373-66) Refer to December 1950 Report.
1950 Borings without Liner Samples. (ORA Proj. 1373-66) Refer to December 1950 Report.
1959 Borings with Liner Samples. (ORA Proj. 01994) Refer to January 1960 Report.
1965 Borings with Liner Samples.
1965 Borings without Liner Samples.
SCALE: 1" = 300'
BORING LOCATION PLAN
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY
ST. CLAIR MICHIGAN
ORA PROJECT NO. 01994

COMPARISON OF AVERAGE SOIL RESISTANCES BETWEEN
1950 AND 1965 BORINGS IN THE POWER PLANT AREA
ST. CLAIR POWER PLANT

1950 Borings: 1 through 12, 17, 18, and 19
1965 Borings: 22, 23, 24, and 25

Elev.	Soil Type		S_c PSF			$S_{uc}/4$ PSF			N Blows/Ft.			Elev. Ft.
			1950 [1]	1965 [2]	All [1 & 2]	1950 [1]	1965 [2]	All [1 & 2]	1950 [3]	1965 [4]	All [3 & 4]	
591	Ground Surface											591
577	Medium to stiff vari-colored clay, trace of gravel.		1500	*	1364	1167	*	1142	14.7	12.8	14.1	577
		575	130	123	151	221	112	201	4.1	2.8	3.9	560
	Very soft brown-gray clay, trace to some sand.	555	100	90	106	118	81	111	2.5	1.8	2.3	545
535		540		*	154	140	*	137	3.5	3.3	3.2	535
				142	168	186	124	175	4.9 $\boxed{12.8}$	4.2 $\boxed{17.3}$	4.8 $\boxed{14.7}$	515
				122	143	155	155	155	6.4	7.3	6.6	500
	Medium sandy gray clay, trace to some gravel.		150	167	172	201	168	195	7.5	8.1	7.7	480
465				159	158	151	149	151	7.8	7.4	7.7	465
		458										

(1) Based on shear test from Borings 1 through 12 only.
(2) Based on shear test from Borings 22 and 25 only.
(3) Based on ASTM penetration from Borings 1 through 12, 17, 18 and 19.
(4) Based on ASTM penetration from Borings 22 through 25.
* Only one or two samples available.
☐ Represent ASTM penetration for the sand layer found in variable thickness in Borings 1, 2, 3, 4, 17, 19, 23, 24, and 25 only between Elevs. 540 and 510.



The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.

OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN ANN ARBOR, MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 22,23,24,25
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY
ST. CLAIR MICHIGAN
APPROVED: W.H. Hansel DATE: 4-5-1966
PROJECT: 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION 590.2 FT. (USING PLANT DATUM)

ELEVATION IN FEET

Elevation	Soil Profile
590	Cinders.
	Medium Sandy Brown Clay, Gravel, Vegetation.
	Stiff Sandy Varicolored Clay, Trace of Gravel.
580	Hard Sandy Varicolored Clay, Trace of Gravel.
	Medium Sandy Varicolored Clay.
570	Soft Gray-Brown Clay, Some Sand.
560	
550	
540	
	Very Soft Gray Clay, Trace of Sand and gravel.
530	
520	
510	
500	
490	Medium Sandy Gray Clay With Some Gravel.
480	
	Stiff Sandy Gray Clay, Some Gravel, Few Large Stones.
470	
	Medium Sandy Gray Clay.
460	
	Very Hard Sandy Gray Clay With Small Sand Seams.
450	Soft Gray Shale.
	Hard Gray Shale. 90% Recovery.
440	Boring Stopped.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

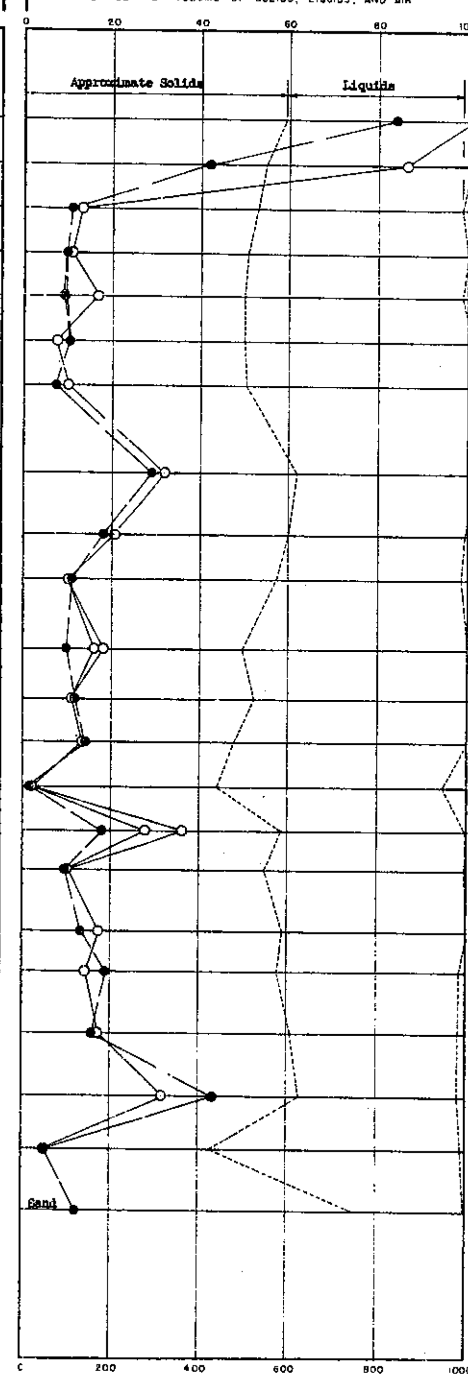
SA NO.	ELEV	LAB CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT LBS. PER CU. FT.	REMARKS
1-BS	587.7	--	10	12			
2-BS	585.2	--	21	12			
3-BS	582.7	--	35	12			
4-LS	580.2	Stiff	14	12	25.8	99.2	4-LS: Uniform. Silty brown-gray laminated clay, trace of gravel.
5-LS	575.2	Plastic to Firm	6	12	33.5	91.8	5-LS: Uniform. Silty brown-gray laminated clay.
6-LS	570.2	Soft	3	12	32.5	88.6	6-LS: Uniform. Gray clay, little silt.
7-LS	565.2	Very Soft	2	12	36.4	84.9	7-LS: Uniform. Gray clay, little silt.
8-LS	560.2	Very Soft	2	12	35.9	84.9	8-LS: Uniform. Gray clay, little silt.
9-LS	555.2	Very Soft	2	12	38.7	83.6	9-LS: Uniform. Gray clay, little silt.
10-LS	550.2	Very Soft	2	12	37.4	84.2	10-LS: Uniform. Gray clay, little silt.
	545.2	--	2	12			
11-LS	540.2	Plastic	6	12	23.9	102.3	11-LS: Uniform. Silty gray clay, trace of very fine sand and fine gravel.
	535.2	--	5	12			
12-LS	533.2	Soft	4	12	25.0	98.9	12-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
13-LS	528.2	Soft	4	12	27.5	94.2	13-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	522.2	--	4	12			
14-LS	520.2	Soft	4	12	38.6	81.7	14-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
15-LS	514.7	Soft	4	12	34.6	86.1	15-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
16-LS	509.7	Soft	5	12	41.6	78.6	16-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
17-LS	504.7	Very Soft	5	12	43.1	73.6	17-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
18-LS	499.7	Plastic	6	12	26.3	98.0	18-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
19-LS	495.2	Soft	7	12	30.5	91.7	19-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	489.7	--	8	12			
20-LS	488.2	Soft	9	12	26.1	98.6	20-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
21-LS	483.7	Soft	10	12	26.4	96.7	21-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	479.7	--	9	12			
22-LS	476.7	Soft	18	12	23.0	101.7	22-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	473.2	--	36	12			
23-LS	469.7	Plastic	21	12	21.1	104.8	23-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
24-LS	463.7	Very Soft	8	12	49.8	71.1	24-LS: Uniform. Gray clay, some silt.
25-LS	456.7	Compact	117	12	12.1	126.0	25-LS: Uniform. Clayey coarse gray sand.
	450.2	--	100	12			

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

▭ Failure to recover Liner Sample.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT BY VOLUME OF SOLIDS, LIQUIDS, AND AIR



○——○ TRANSVERSE SHEARING RESISTANCE IN LBS. PER SQ. FT.

●- - -● ONE HALF COMPRESSION STRENGTH IN LBS. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE SOIL MECHANICS LABORATORY	
ANN ARBOR	MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 22 ST. CLAIR POWER PLANT	
THE DETROIT EDISON COMPANY	ST. CLAIR, MICHIGAN
APPROVED: W. A. Housel	DATE: 4-5-1966

PROJECT: 01994

Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. Their Job No. CB-4043-D
Date of Boring: 7-31-1965

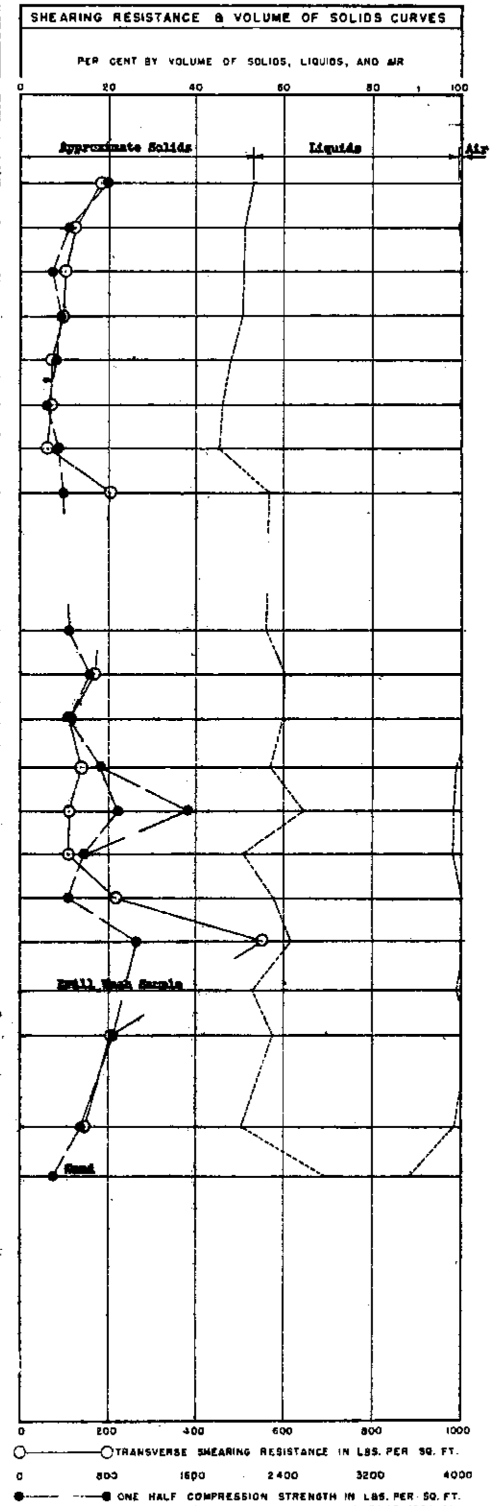
LOG OF SOIL PROFILE
BY R.C.P. DIVISION
GROUND SURFACE ELEVATION 589.5 FT. (USING PLANT DATUM)

Elevation	Soil Profile
580–550	Medium Sandy Varicolored Clay, Some Gravel.
	Stiff Sandy Brown Clay.
	Soft Brown Clay, Some Sand.
	Very Soft Gray Clay, Some Sand, Trace of Gravel.
540	Firm Medium to Fine Gray Sand.
530–520	Soft Sandy Gray Clay, Trace of Gravel.
510–490	Medium Sandy Gray Clay, Some Gravel.
480	Firm Fine to Medium Gray Sand.
	Medium Sandy Gray Clay.
470	Very Compact Medium Gray Sand.
460	Very Compact Fine to Medium Gray Sand, Few Seams of Clayey Sand.
	Boring Stopped.
450	

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT. LBS. PER CU. FT.	REMARKS
1-SS	587.0	—	6	12			
2-SS	584.5	—	9	12			
3-SS	582.0	—	19	12			
4-LS	579.5	Soft	3	12	33.6	89.2	4-LS: Uniform. Gray clay, little silt.
5-LS	574.5	Very Soft	2	12	35.3	85.3	5-LS: Uniform. Gray clay, little silt.
6-LS	569.5	Very Soft	2	12	36.8	85.5	6-LS: Uniform. Gray clay, little silt.
7-LS	564.5	Very Soft	2	12	36.4	84.9	7-LS: Uniform. Gray clay, little silt.
8-LS	559.5	Very Soft	1	12	41.0	80.5	8-LS: Uniform. Gray clay, little silt.
9-LS	554.5	Very Soft	1	12	43.2	77.4	9-LS: Uniform. Gray clay, little silt.
10-LS	549.5	Very Soft	2	12	45.6	76.1	10-LS: Uniform. Gray clay, little silt.
11-LS	544.5	Soft	3	12	29.4	90.2	11-LS: Uniform. Gray Clay, little silt.
12-SS	539.5	—	20	12			
13-SS	534.5	—	25	12			
14-LS	529.0	Soft	4	12	30.3	92.4	14-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
15-LS	524.0	Soft	4	12	25.0	99.2	15-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
16-LS	519.0	Soft	3	12	27.8	98.2	16-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
17-LS	513.5	Soft	6	12	28.1	93.6	17-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
18-LS	508.5	Soft to Plastic	18	12	18.8	108.2	18-LS: Uniform. Silty gray clay, some sand, trace of gravel.
19-LS	503.5	Soft	11	12	34.8	84.2	19-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
20-LS	498.5	Soft	8	12	28.7	96.7	20-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
21-LS	493.5	Plastic	8	12	25.9	—	21-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
22-LS	488.0	Very Soft	8	12	31.0	88.8	22-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
23-LS	483.0	Soft	8	12	28.4	96.7	23-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
24-SS	477.5	—	45	12			
25-LS	472.5	Soft	6	12	39.6	84.2	25-LS: Uniform. Silty gray clay.
26-LS	467.0	Loose	67	12	18.1	116.7	26-LS: Uniform. Fine gray sand, trace of clay.
27-SS	462.7	—	200	12			
28-SS	458.0	—	208	12			

PENETRATION: Number of blows required to drive case sampler distance given using a 140-pound weight falling 30 inches.

Failure to recover Liner Sample.



UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 25
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY ST. CLAIR, MICHIGAN
APPROVED: W. S. Housel DATE: 4-5-1966
PROJECT: 01994

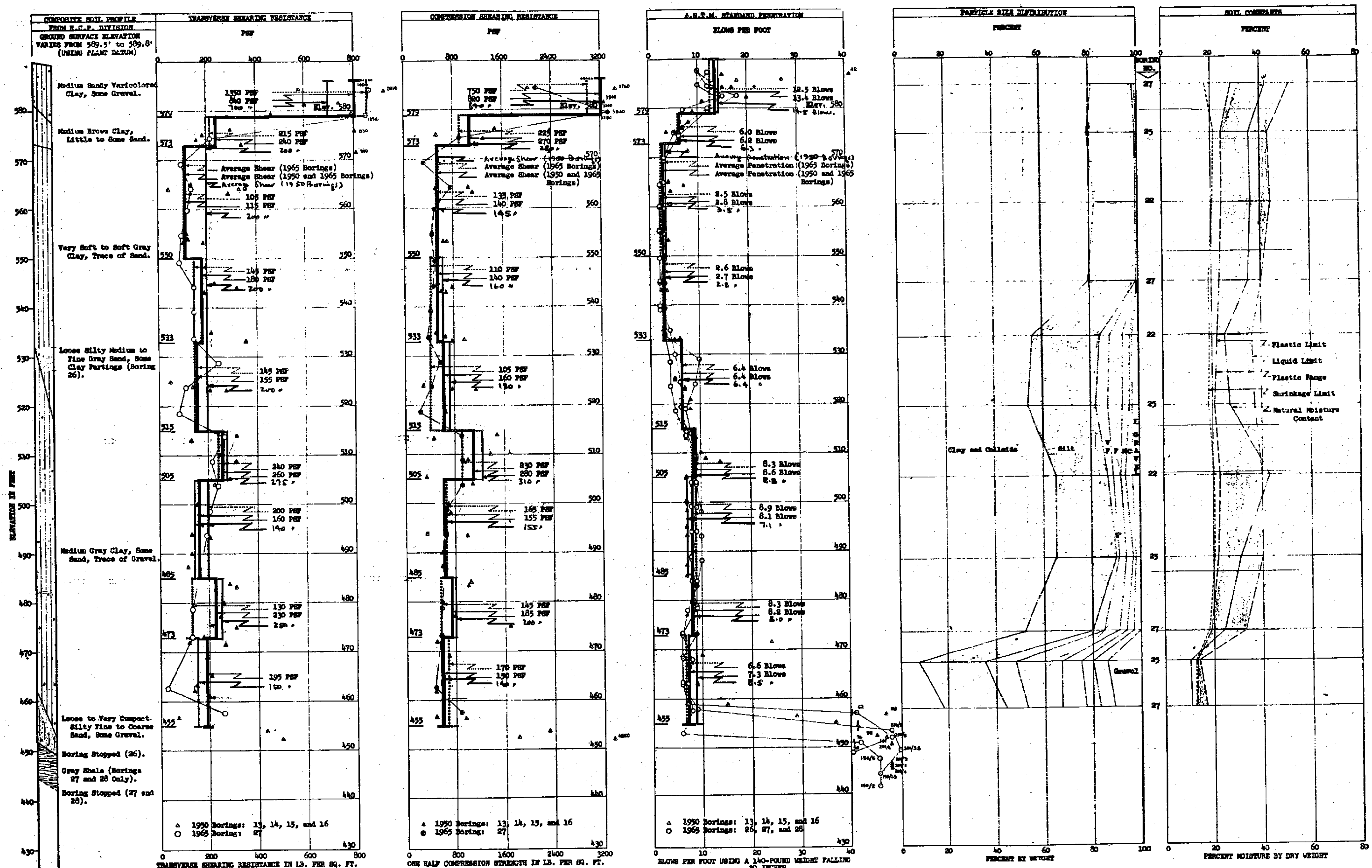
Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc.
Their Job No. CB-4043-D
Date of Boring: 7-1-1965

COMPARISON OF AVERAGE SOIL RESISTANCES BETWEEN
1950 AND 1965 BORINGS FOR THE YARD'S CONVEYOR
ST. CLAIR POWER PLANT

1950 Borings: 13, 14, 15, and 16
1965 Borings: 26, 27, and 28

	Soil Type	S_c PSF			$S_{uc}/4$ PSF			N Blows/Ft.			Elev. Ft.
		1950[1]	1965[2]	All[1,2]	1950[1]	1965[2]	All[1,2]	1950[1]	1965[3]	All[1,3]	
590	Ground Surface										590
579	Medium sandy vari-colored clay, some gravel.	700	1350[5]	840	840	750[5]	818	14.5	12.5	13.4	579
573	Medium brown clay, little to some sand.	200	216[4]	241	280	226[4]	270	6.3	6.0	6.2	573
	Very soft to soft gray clay, trace of sand.	200	106	116	144	136	142	3.5	2.5	2.8	550
533		200	144	178	159	108	142	2.8	2.6	2.7	533
	Medium gray clay, some sand, trace of gravel.	200	145	155	182	103	159	6.4	6.4	6.4	515
		275	240	260	312	232	278	8.8	8.3	8.6	505
		140	198[5]	161	154	165[5]	156	7.1	8.9	8.1	485
		250	130[5]	230	202	144[5]	185	8.0	8.3	8.2	473
455		150	259[4]	195	140	170[5]	150	8.5	6.6	7.3	455

(1) Based on shear tests and ASTM penetration values from Borings 13, 14, 15, and 16.
(2) Based on shear tests from Boring 27 only.
(3) Based on ASTM penetration values from Borings 26, 27, and 28.
(4) Based on one shear value only.
(5) Based on two shear values only.



The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.

OFFICE OF RESEARCH ADMINISTRATION,
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN — ANN ARBOR, MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 26, 27 & 28
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY
ST. CLAIR — MICHIGAN
APPROVED W. S. Housel — DATE 4-5-1966
OFFICE OF RESEARCH ADMINISTRATION PROJECT NO. 01994

LOG OF SOIL PROFILE
BY R.C.P. DIVISION
GROUND SURFACE ELEVATION 589.8 FT. (USING PLANT DATUM)

- Clay, Silt.
- Medium Sandy Varicolored Clay, Some Gravel.
- Stiff Sandy Varicolored Clay, Some Gravel.
- Medium Sandy Varicolored Clay.
- Medium Brown Gray Clay.
- Soft Gray Clay, Trace of Sand.
- Medium Sandy Gray Clay, Trace of Gravel, Some Coarse Sand.
- Medium Gray Clay, Seams and Partings of Fine to Medium Silty Gray Sand.
- Loose Silty Clayey Fine to Medium Gray Sand.
- Very Compact Medium to Coarse Gray Sand.
- Grey Shale, Seams of Hard Gray Clay.
- Boring Stopped.

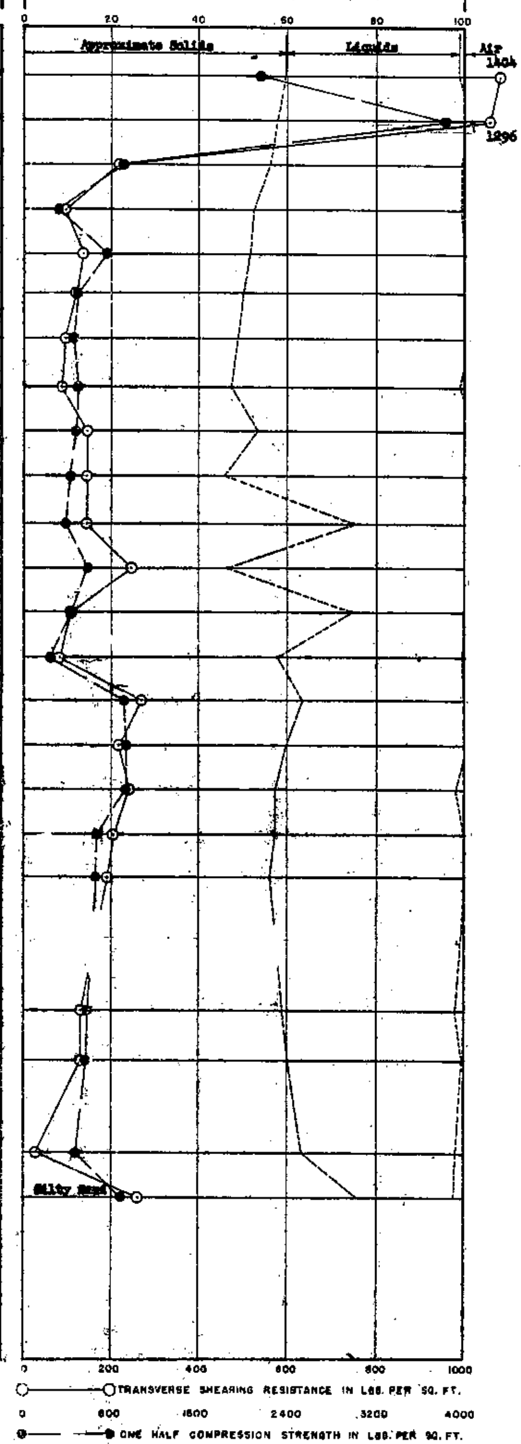
Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. Their Job No. CE-4043-D Date of Boring: 7-8-1964

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV	LAB. CONSISTENCY	PENETRATION NO OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LBS. PER CU. FT.	REMARKS
1-DS	587.3	—	10	12			
2-LS	584.3	Firm	18	12	24.6	99.8	2-LS: Uniform. Brown-gray laminated clay, little silt, trace of sand.
3-DS	582.3	—	18	12			
4-LS	579.3	Stiff	18	12	28.3	96.7	4-LS: Uniform. Brown-gray laminated clay, little silt, trace of sand.
5-LS	574.3	Soft	6	12	28.8	94.2	5-LS: Uniform. Brown-gray laminated clay, little silt, trace of sand.
6-LS	569.3	Soft	3	12	33.3	88.0	6-LS: Uniform. Gray clay, little silt, trace of sand.
7-LS	564.3	Soft	2	12	34.8	86.7	7-LS: Uniform. Gray clay, little silt, trace of sand.
8-LS	559.8	Soft	2	12	40.0	84.2	8-LS: Uniform. Gray clay, little silt, trace of sand.
9-LS	554.8	Soft	2	12	40.0	81.7	9-LS: Uniform. Gray clay, little silt, trace of sand.
10-LS	549.3	Soft	3	12	40.7	79.8	10-LS: Uniform. Gray clay, little silt, trace of sand.
11-LS	544.3	Soft	3	12	34.7	89.2	11-LS: Uniform. Gray clay, little silt, trace of sand.
12-LS	539.3	Soft	3	12	44.0	76.8	12-LS: Uniform. Gray clay, little silt, trace of sand.
13-LS	533.8	Soft	3	12	18.6	124.8	13-LS: Uniform. Silty gray clay, some pockets of fine sand.
14-LS	528.8	Soft	15	12	45.0	76.1	14-LS: Uniform. Silty gray clay.
15-LS	523.8	Soft	9	12	13.0	122.6	15-LS: Uniform. Silty gray clay, some pockets and layers of sand.
16-LS	518.8	Very Soft	7	12	27.3	95.3	16-LS: Uniform. Silty gray clay, little sand.
17-LS	513.8	Soft	8	12	16.7	104.2	17-LS: Uniform. Silty gray clay, little sand.
18-LS	508.8	Soft	9	12	26.0	98.6	18-LS: Uniform. Silty gray clay, little sand.
19-LS	503.8	Soft	8	12	27.4	94.2	19-LS: Uniform. Silty gray clay, little sand.
20-LS	498.8	Soft	8	12	28.0	95.5	20-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
21-LS	493.8	Soft	9	12	29.4	93.6	21-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
22-DS	487.3	—	8	12			
	483.8	—	9	12			
23-LS	478.8	Soft	9	12	24.6	98.6	23-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
24-LS	473.3	Soft	9	12	18.5	108.3	24-LS: Uniform. Silty gray clay, little sand, trace of fine gravel.
25-DS	468.3	—	6	12			
26-LS	462.8	Very Soft	6	12	20.4	106.1	26-LS: Uniform. Silty gray clay, honeycombed.
27-LS	457.8	Soft	9	12	18.8	107.3	27-LS: Uniform. Silty gray sand, some clay and gravel.
28-DS	453.3	—	200	12			
29-DS	449.3	—	390	12			
30-DS	444.6	—	190	12			

— Failure to recover Liner Sample.

PENETRATION: Number of blows required to drive sample distance given using a 140-pound weight falling 30 inches.

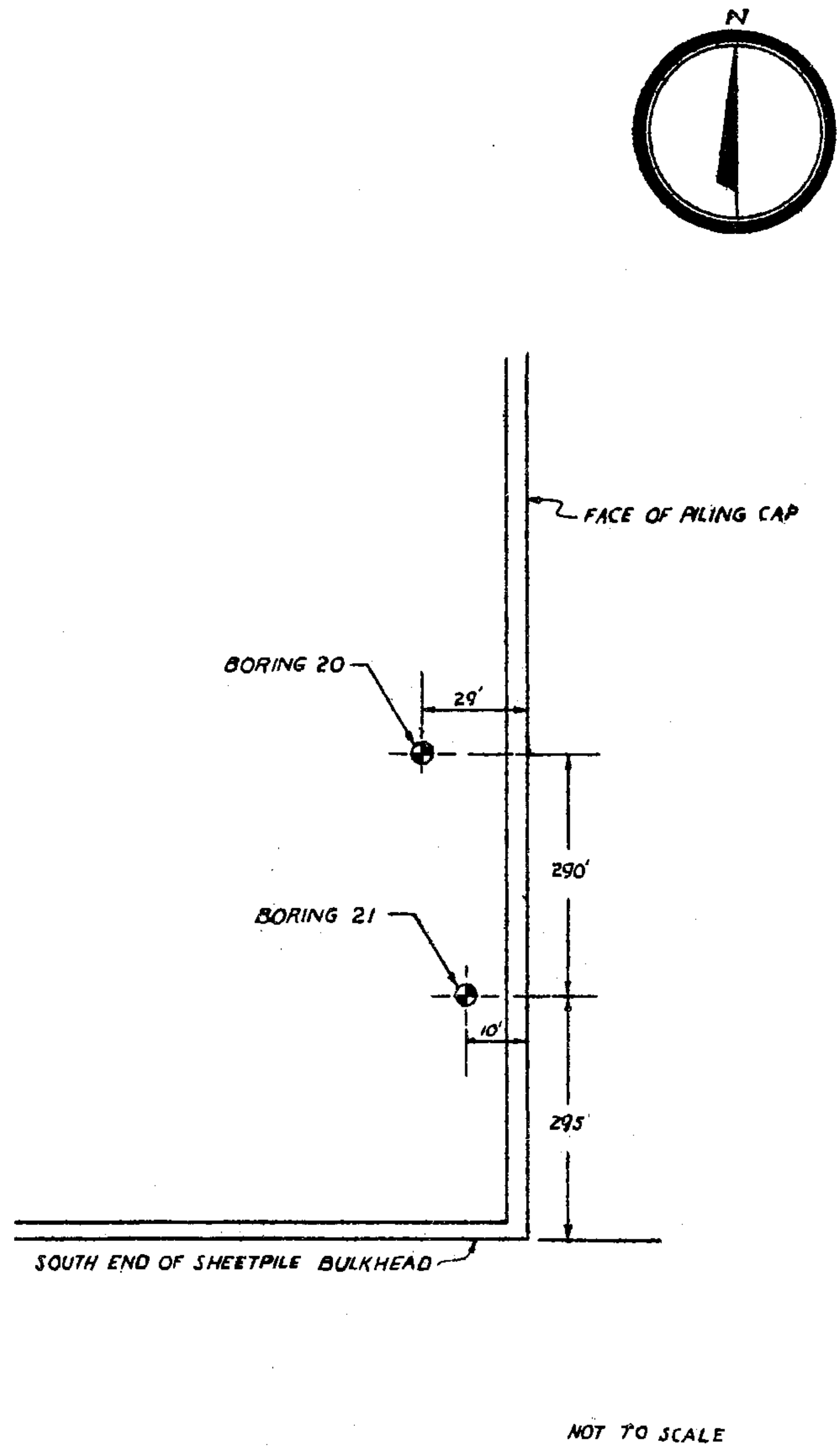
SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



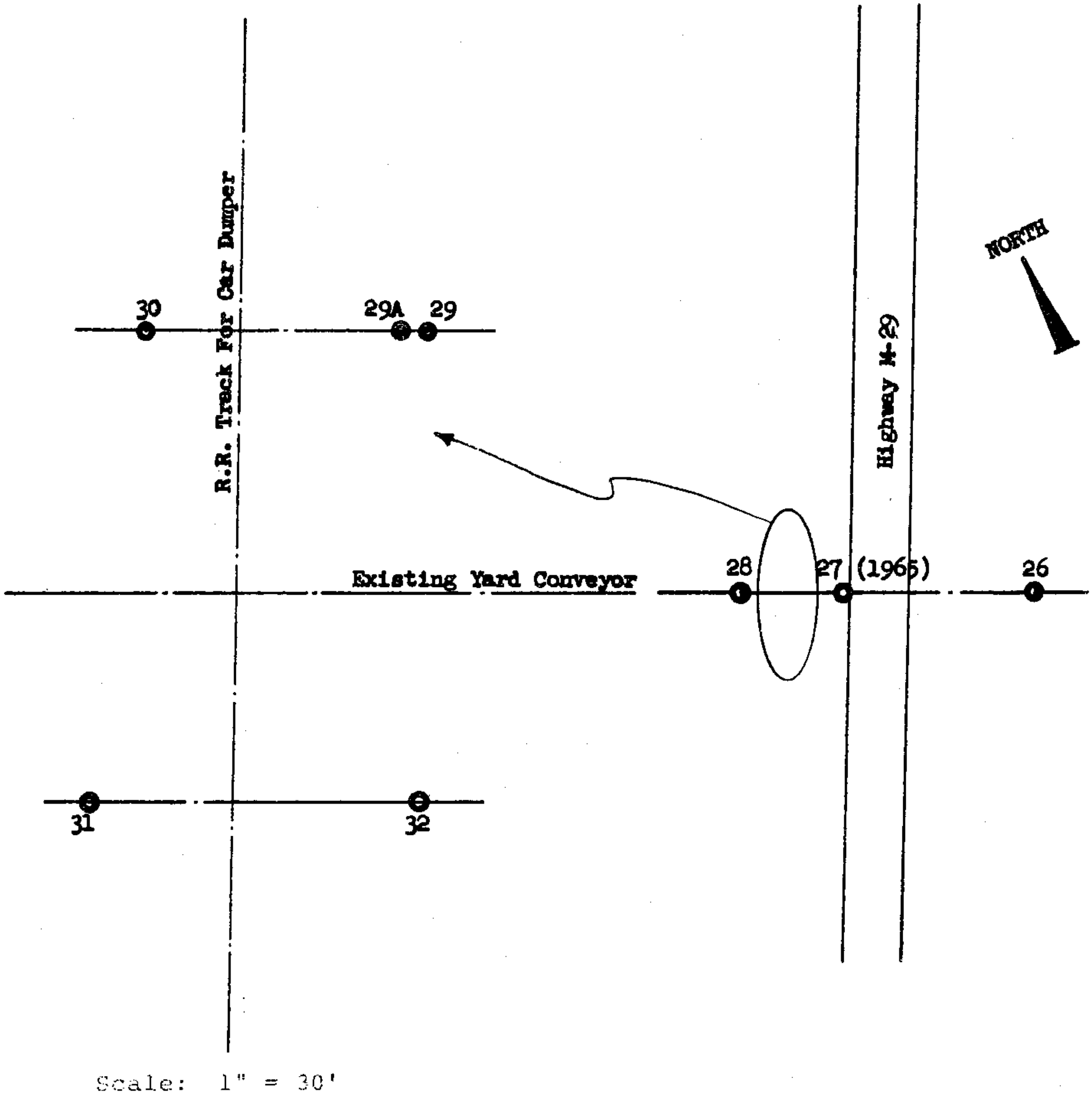
UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE SOIL MECHANICS LABORATORY	
ANN ARBOR	MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 27 ST. CLAIR POWER PLANT	
THE DETROIT EDISON COMPANY	ST. CLAIR, MICHIGAN
APPROVED: W. A. Hoasel	DATE: 4-5-1966

PROJECT: 01994

ADDITIONAL St. CLAIR PLANT INFORMATION



BORING LOCATION PLAN
ST. CLAIR POWER PLANT
DETROIT EDISON COMPANY
DETROIT MICHIGAN
UNIV. OF MICHIGAN PROJECT 01994



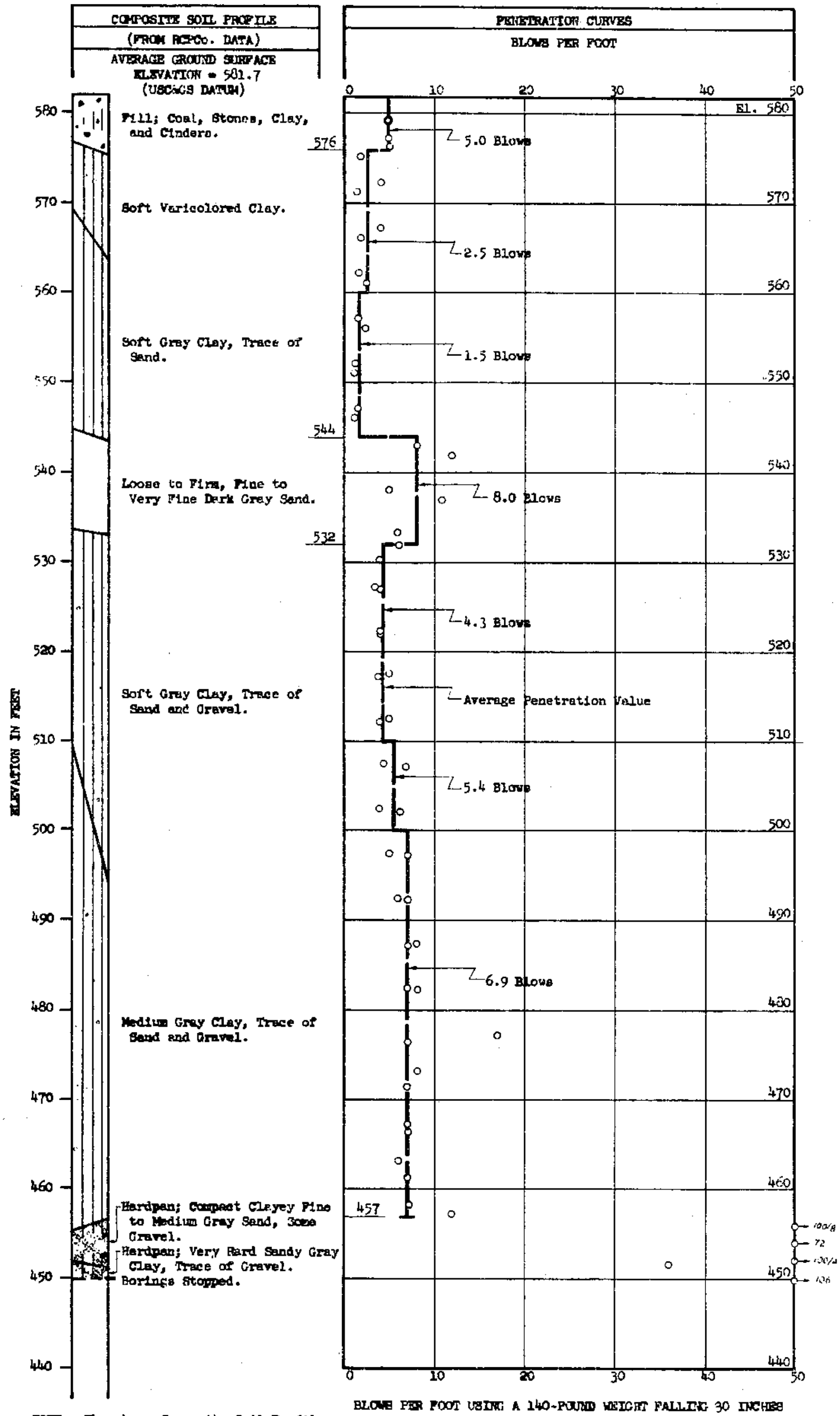
● 1965 and 1966 Borings with Liner Samples

◉ 1965 Borings without Liner Samples

Scale: 1" = 300'

BORING LOCATION PLAN	
CAR DUMPER HOUSE ST. CLAIR POWER PLANT THE DETROIT EDISON CO.	
BELLE RIVER	MICHIGAN

GRA PROJECT NO. 01994



NOTE: The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual boring charts for details.

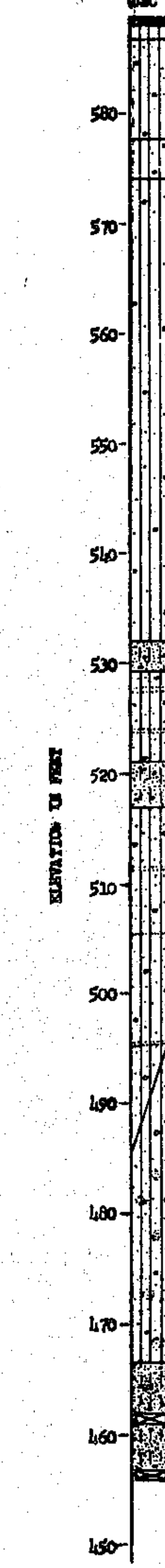
UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN

PENETRATION VALUES OF BORINGS NO. 20 and 21
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN

APPROVED: DATE:

Boring Logs

LOG OF SOIL PROFILE BY RCPCo VISUAL INSPECTION GROUND SURFACE ELEVATION = 588.7' (USC & GS DATUM)
Topsoil.
Med. V.-Colored Clay.
Hard Vari-Colored Clay, Little Sand, Trace of Gravel.
Med. Vari-Colored Clay, Tr. Sand & Gravel.
Soft Blue Clay, Trace of Sand & Gravel.
Clayey, Med. Dark Sand, Little Gravel.
Soft Blue Clay, Little Sand & Gravel, Seams of Sand.
Clayey, V.Fine, Dark Sand, Little Gravel.
Seam of Clayey, Fine Gray Sand.
Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.
Medium Blue Clay, Little Sand & Gravel. Sand Inclusions.
Hardpan; Compact Clayey Fine Gray Sand, Seams of Clean Sand & Gr., Few Boulders.
Boring Stopped.



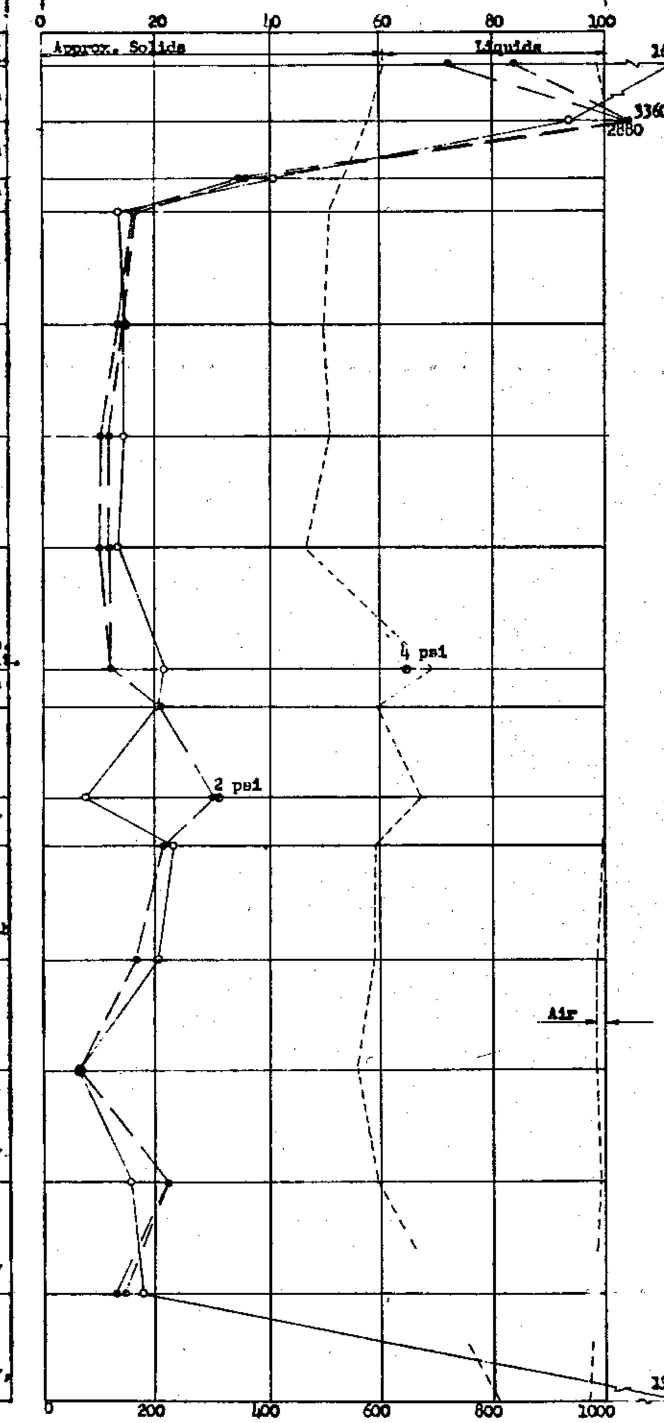
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	585.7	Hard	15	12	23.3	101.7	1-LS: Uniform, very fine texture. Smooth vari-colored clay. Little silt. Sl. tr. sand.
2-LS	580.7	V.Stiff	24	12	27.4	97.3	2-LS: Uniform, very fine texture. Smooth vari-colored clay. Little silt.
3-LS	575.7	Stiff	7	12	36.9	86.1	3-LS: Uniform, very fine texture. Smooth vari-colored clay. Little silt.
4-LS	572.7	Soft	3	12	35.8	85.5	4-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
5-LS	562.7	Soft	3	12	38.4	83.6	5-LS: Uniform, very fine texture. V. smooth blue clay. Little silt.
6-LS	552.7	Soft	3	13	36.7	84.9	6-LS: Uniform, very fine texture. V. smooth blue clay. Little silt.
7-LS	542.7	Soft	3	12	43.1	78.0	7-LS: Uniform, very fine texture. V. smooth silty blue clay.
8-LS	531.7	W.C.	10	12	16.9	114.8	8-LS: Uniform, very fine to fine texture. V.f. to f. gray sand. Some cl., little silt.
9-LS	528.4	Soft	5	12	24.8	100.2	9-LS: Uniform, very fine texture. Smooth blue clay. Little silt, tr. sand.
10-LS	520.2	W.C.	12	12	19.0	111.1	10-LS: Uniform, very fine texture. Dark gray clayey silt and very fine sand.
11-LS	515.9	Plastic	7	13	25.6	99.2	11-LS: Uniform, very fine texture. Silty blue clay. Trace sand.
12-LS	505.7	Plastic	7	12	24.7	98.6	12-LS: Uniform, very fine texture. Smooth blue clay with little silt and sand.
13-LS	495.7	V.Soft	8	13	28.0	94.2	13-LS: Uniform, very fine texture. Blue clay with some silt & little sand.
14-LS	485.7	Soft	8	12	25.2	99.2	14-LS: Uniform, very fine texture. Silty blue clay with little sand.
15-LS	475.7	Soft	8	12	42.8	- -	15-LS: Uniform, very fine texture. Silty blue clay.
16-LS	466.2	Hard	222	12	7.3	136.0	16-LS: Uniform, very fine texture. Sandy, silty gray clay with pebbles.
	461.4	- -	200	6			PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.
	456.5	- -	200	4			

⊠ Indicates failure to recover Liner Sample.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. D-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT OF VOLUME OF SOLIDS, LIQUIDS, AND AIR



○———○ TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

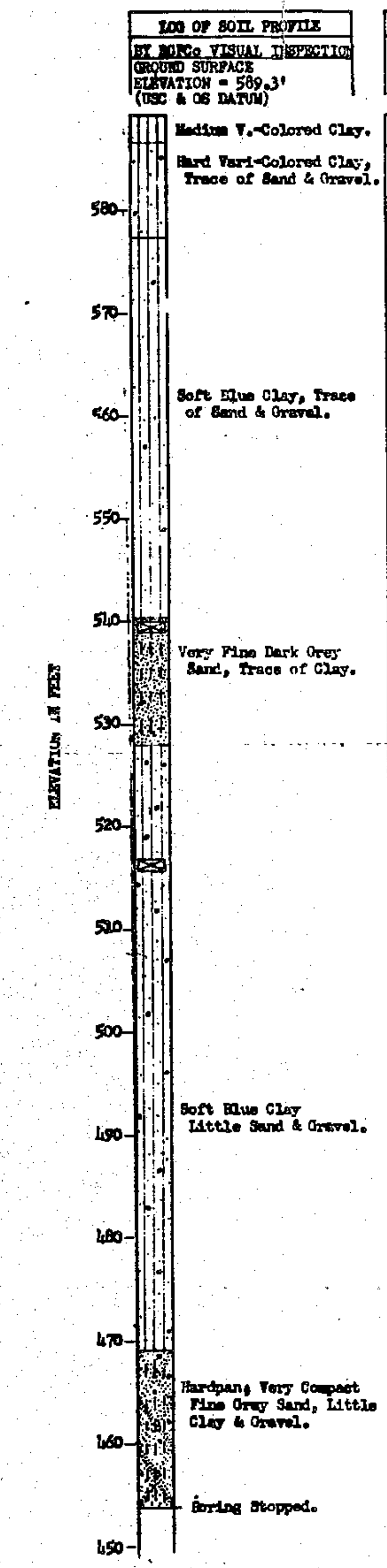
0 800 1600 2400 3200 4000

●— — —● ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

● TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE AS INDICATED.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 3 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY
APPROVED: W.S. Housel DATE: 12-5-50

UNIVERSITY OF MICHIGAN PROJECT M373-66

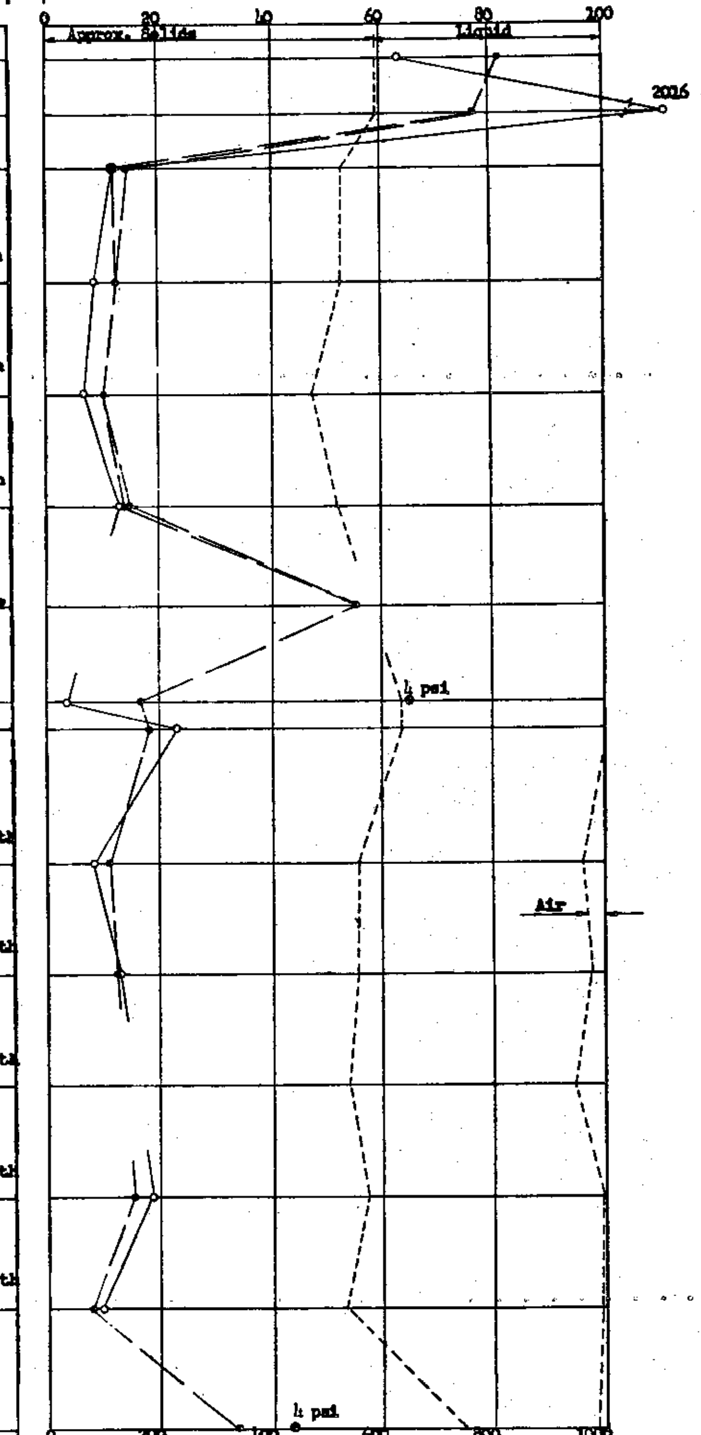


Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. 3-7153-D.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	586.3	V.Stiff	14	12	26.5	99.8	1-LS: Uniform, very fine texture. Silty vari-colored clay with trace organic.
2-LS	581.3	Hard	22	12	26.5	99.2	2-LS: Uniform, very fine texture. Silty vari-colored clay. Trace pebbles.
3-LS	576.5	Soft	4	13	35.5	88.6	3-LS: Uniform, very fine texture. Silty blue clay. Sl. trace sand.
4-LS	566.3	Soft	3	12	34.8	88.0	4-LS: Uniform, very fine texture. Smooth blue clay with little silt.
5-LS	556.3	V.Soft	2	11	42.3	79.2	5-LS: Uniform, very fine texture. Smooth blue clay with little silt.
6-LS	546.3	Soft	2	11	36.0	86.7	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
	539.5	- -	12	12			
7-LS	537.3	Weakly Coherent	9	12	20.0	- -	7-LS: Uniform, very fine texture. Gray very fine to fine sand with little silt.
8-LS	528.7	Weakly Coherent	7	12	21.8	104.8	8-LS: Uniform, very fine texture. Gray very fine sand with some clay & silt.
9-LS	526.3	Soft	6	12	22.0	106.1	9-LS: Uniform, very fine texture. Blue clay with little silt and sand. Tr. pebb.
	516.3	- -	6	12			
10-LS	514.3	V.Soft	7	12	26.9	93.0	10-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
11-LS	504.3	Soft	8	12	28.1	93.0	11-LS: Uniform, very fine texture. Smooth silty blue clay.
12-LS	494.3	V.Soft	9	12	28.0	90.5	12-LS: Uniform, very fine texture. Smooth silty blue clay.
13-LS	484.3	Soft	9	12	27.6	96.1	13-LS: Uniform, very fine texture. Smooth silty blue clay.
14-LS	474.3	V.Soft	9	12	31.9	89.9	14-LS: Uniform, very fine texture. Smooth silty blue clay.
15-LS	463.5	Weakly Coherent	71	12	11.8	124.8	15-LS: Uniform, v.fine to fine texture. Clayey v.fine to fine gray sand.
16-BS	459.1	Compact	225	5			16-BS: Uniform, v.fine to fine texture. Clayey v.fine to fine gray sand.
	454.3	- -	200	3			

⊠ Indicates failure to recover Liner Sample.
PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



○———○ TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.
0 800 1600 2400 3200 4000
●— —● ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.
● TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 1
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

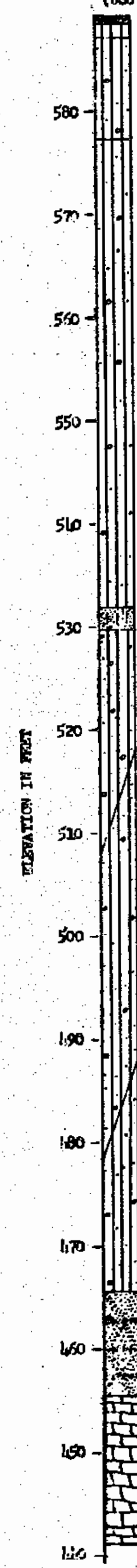
APPROVED: W.S. Housel DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M373-66

LOG OF SOIL PROFILE

BY RCPCo VISUAL INSPECTION

GROUND SURFACE ELEVATION = 589.3' (USC & GS DATUM)



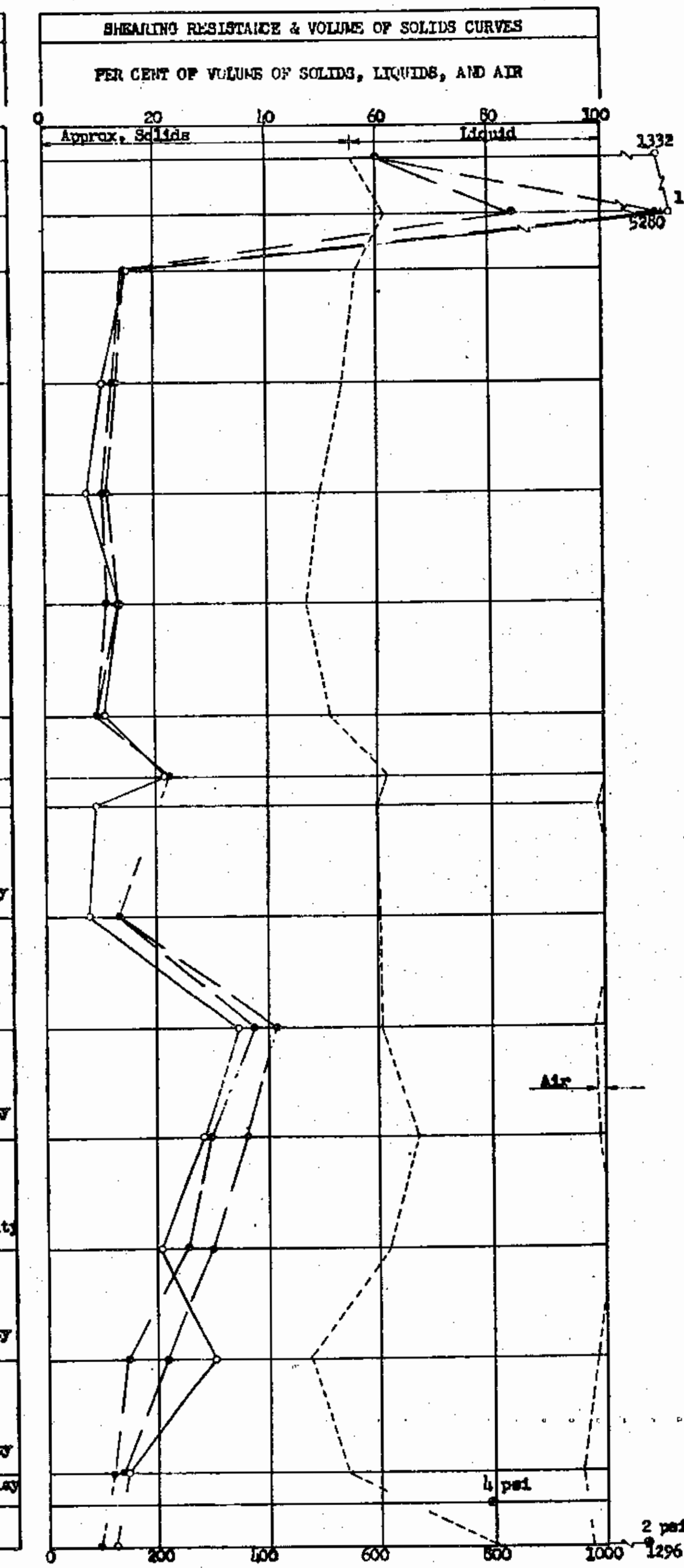
- Topsoil.
- Med. Vari-Colored Clay.
- Hard Vari-Colored, Trace of Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Med. to Course Sand & Gravel, Little Clay.
- Soft Blue Clay, Little Sand & Gravel.
- Medium Blue Clay, Little Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Hardpan; Compact Fine to Medium Gray Sand, Little Gravel and Clay, Seams of Clayey Sand. Few Boulders.
- Probably Fractured Blue Shale.
- Boring Stopped.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. 9-7153-D.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION: NO. OF BLOWS	PENETRATION: DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	586.3	V. Stiff	15	12	29.7	93.6	1-LS: Uniform, very fine texture. Vari-colored with little silt.
2-LS	581.3	V. Stiff	14	12	25.2	103.0	2-LS: Uniform, very fine texture. Silty vari-colored clay.
3-LS	576.3	Soft	4	13	29.7	94.2	3-LS: Uniform, very fine texture. Silty blue clay.
4-LS	566.3	Soft	3	12	33.3	90.5	4-LS: Uniform, very fine texture. Silty blue clay.
5-LS	556.3	Soft	3	13	38.5	83.0	5-LS: Uniform, very fine texture. Silty blue clay.
6-LS	546.3	Soft	3	13	41.3	79.2	6-LS: Uniform, very fine texture. Silty blue clay.
7-LS	536.3	Soft	4	14	34.9	86.1	7-LS: Uniform, very fine texture. Silty blue clay. Trace sand and pebbles.
8-LS	530.8	Soft to Plastic	22	12	23.8	103.0	8-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand & pebs.
9-LS	528.3	V. Soft	6	12	23.0	100.5	9-LS: Uniform, very fine texture. Blue clay with little silt. Tr. pebbles.
10-LS	518.3	Soft	7	12	26.0	101.1	10-LS: Uniform, very fine texture. Sandy blue clay with some silt. Tr. pebbles.
11-LS	508.3	Plastic to Firm	9	12	23.4	101.1	11-LS: Uniform, very fine texture. Blue clay with some silt. Tr. pebbles.
12-LS	498.3	Plastic	9	12	17.7	112.3	12-LS: Uniform, very fine texture. Silty blue clay.
13-LS	488.3	Plastic	11	12	23.8	103.6	13-LS: Uniform, very fine texture. Silty blue clay with pebbles.
14-LS	478.3	Plastic	8	12	40.1	79.9	14-LS: Uniform, very fine texture. Silty blue clay. Tr. sand. Internal voids.
15-LS	468.3	Plastic	8	12	39.5	78.0	15-LS: Uniform, very fine texture. Silty blue clay. Internal voids.
16-LS	465.4	Non.C.	159	12	--	--	16-LS: Non-uniform. Varies from blue clay to medium gray sand.
17-LS	461.0	W.C.	200	8	7.9	136.0	17-LS: Uniform, coarse texture. Clayey silt and sand with little gravel.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

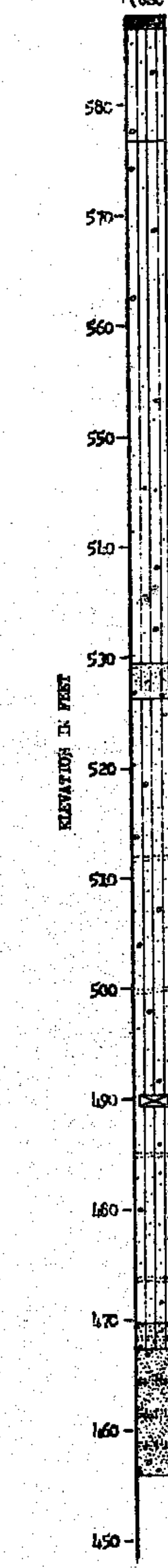
TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE AS INDICATED.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 2
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.S. Housel DATE: 12-15-50

UNIVERSITY OF MICHIGAN PROJECT 1873-66

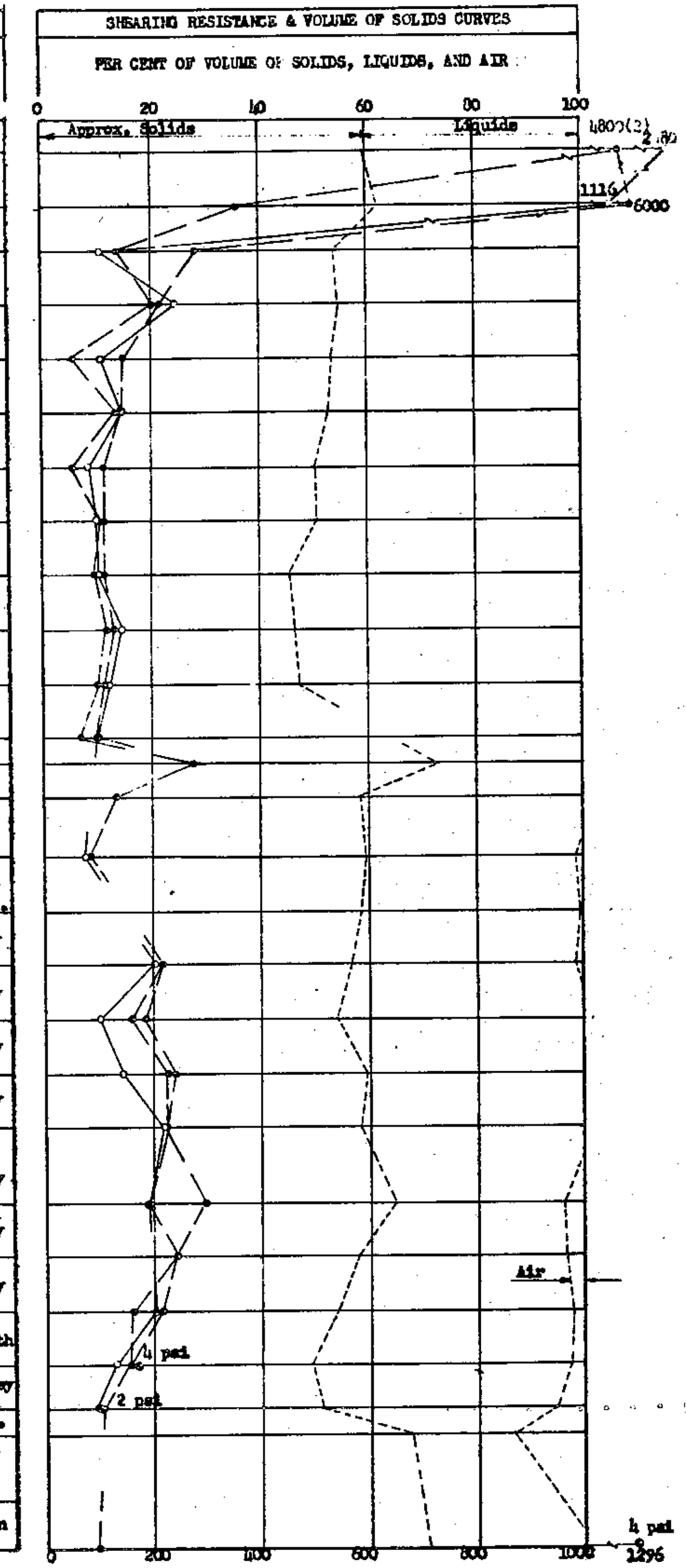


LOG OF SOIL PROFILE BY RCPCo VISUAL INSPECTION GROUND SURFACE ELEVATION = 588.2' (USC & GS DATUM)	SOIL SAMPLE SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	LABORATORY VISUAL INSPECTION REMARKS
Topsoil	1-LS	585.2	Hard	18	12	24.8	99.8	1-LS: Uniform, fine texture. Vari-colored clay with little silt.
Hard Vari-Colored Clay, Trace of Sand & Gravel.	2-LS	580.2	V.Stiff	20	12	23.0	104.2	2-LS: Uniform, very fine texture. Silty vari-colored clay. Trace pebbles.
	3-LS	576.2	Plastic	4	13	32.4	90.5	3-LS: Uniform, very fine texture. Silty blue clay.
	4-LS	571.2	Plastic	3	12	30.6	91.7	4-LS: Uniform, very fine texture. Silty blue clay. Trace of pebbles.
	5-LS	566.2	Soft	4	14	32.9	89.2	5-LS: Uniform, very fine texture. Smooth silty blue clay.
	6-LS	561.2	Soft	4	13	33.8	88.6	6-LS: Uniform, very fine texture. Blue clay with little silt.
Soft Blue Clay, Trace of Sand & Gravel.	7-LS	556.2	Soft	3	12	38.4	84.2	7-LS: Uniform, very fine texture. Silty blue clay.
	8-LS	551.2	Soft	3	14	36.4	85.5	8-LS: Uniform, very fine texture. Silty blue clay.
	9-LS	546.2	Soft	3	14	45.3	76.1	9-LS: Uniform, very fine texture. Silty blue clay with little sand.
	10-LS	541.2	Soft	3	14	43.3	77.4	10-LS: Uniform, very fine texture. Silty blue clay.
	11-LS	536.2	Soft	3	12	42.3	79.2	11-LS: Uniform, very fine texture. Silty blue clay.
← Few Sand Inclusions.	12-LS	531.2	Soft	3	13	43.4	- -	12-LS: Uniform, very fine texture. Silty blue clay.
Clayey Fine Dark Sand, Little Gravel.	13-LS	528.9	W.C.	10	12	14.2	119.8	13-LS: Uniform, fine texture. F. to med. gray clayey sand, tr. of gravel.
	14-LS	525.7	V.Soft	6	12	28.1	98.0	14-LS: Uniform, very fine texture. Silty blue clay. Trace pebbles.
	15-LS	520.2	V.Soft	7	12	24.6	99.8	15-LS: Uniform, very fine texture. Silty blue clay with tr. of gravel.
	16-LS	515.2	V.Soft	8	13	26.4	98.0	16-LS: Uniform, very fine texture. Silty blue clay, little sand. Tr. gr. Disturbed.
	17-LS	510.2	V.Soft	7	12	27.1	95.5	17-LS: Uniform, very fine texture. Silty blue clay. Trace pebbles.
	18-LS	505.2	V.Soft	7	12	32.7	90.5	18-LS: Uniform, very fine texture. Silty blue clay.
	19-LS	500.2	Plastic	8	13	27.8	94.8	19-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.
Medium Blue Clay, Little Sand & Gravel, Few Seams of Sand.	20-LS	495.2	Plastic	8	12	28.2	97.3	20-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.
		490.2	- -	9	12			
	21-LS	488.2	Plastic	9	12	18.3	108.6	21-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.
	22-LS	483.2	Soft	10	12	25.1	96.7	22-LS: Uniform, very fine texture. Silty blue clay. Little sand. Trace pebbles.
	23-LS	478.2	Plastic	9	12	30.1	90.5	23-LS: Uniform, very fine texture. Silty blue clay with little sand.
	24-LS	473.2	Soft	8	12	36.8	82.4	24-LS: Uniform, very fine texture. Smooth blue clay with little silt. Int. voids.
Sandy Medium Blue Clay, Seams of Sand, Little Gr.	25-LS	469.2	Soft	10	12	32.4	86.1	25-LS: Uniform, very fine texture. Clayey gray silt with little sand.
	26-LS	466.7	W.C.	60	12	10.3	114.2	26-LS: Uniform, fine texture. Clean v.f. to f. gray sand. Seams silty clay.
Hardpan; Compact Fine Gray Sand, Trace Gravel, Seams of Sandy Clay.	27-BS	460.8	Compact	200	5			27-BS: Uniform, fine texture. Silty very fine to fine gray sand.
Boring Stopped.	28-LS	455.8	Hard	320	10	16.5	117.3	28-LS: Uniform, very fine texture. Clean v.f. gray sand and silt. Seams of clay.

⊠ Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

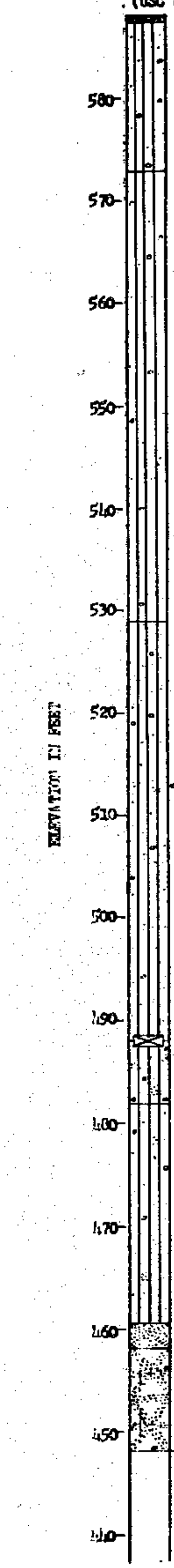
ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

• TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE AS INDICATED.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 4 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY
APPROVED: W.S. Housel DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M373-66

LOG OF SOIL PROFILE
BY RCPCo VISUAL INSPECTION
GROUND SURFACE ELEVATION = 588.± (USC & GS DATUM)



- Topsoil.
- Hard Vari-Colored Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Sand Inclusions.
- Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.
- Med. Hard Blue Clay, Some Sand Inclusions, Little Gravel.
- Soft Blue Clay, Trace of Sand, Gravel & Sand Inclusions.
- Hardpan; Fine to Med. Gray Sand.
- Hardpan; Some Clay, Trace of Gravel, Seams of Sand and Hard Sandy Clay.
- Boring Stopped.

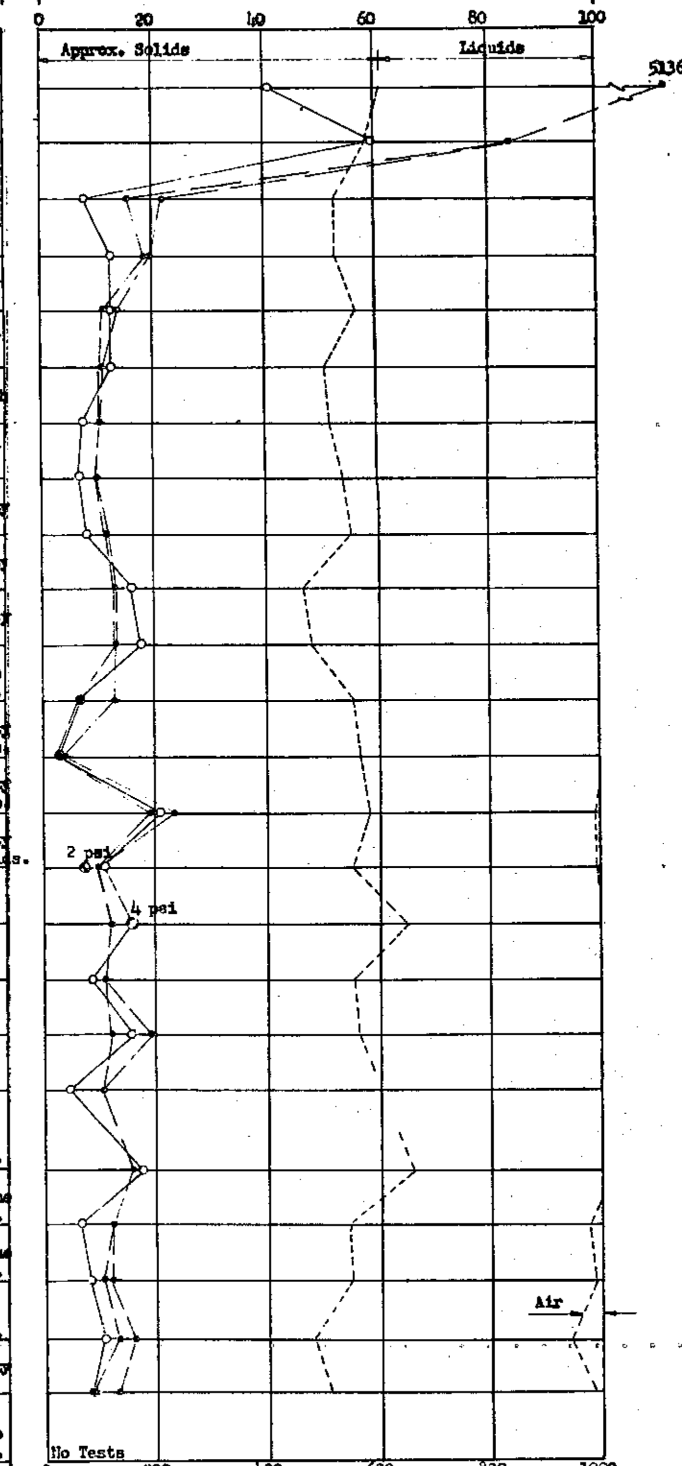
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-BS	584.5	- -	10	12			
2-LS	583.0	F.Stiff	21	12	24.9	102.3	2-LS: Uniform, very fine texture. Vari-colored clay with little silt.
3-LS	578.0	Plastic	15	12	26.8	98.6	3-LS: Uniform, very fine texture. Silty vari-colored clay with tr. pebbles.
4-LS	573.0	Soft	6	12	33.7	88.6	4-LS: Uniform, very fine texture. Silty blue clay.
5-LS	568.0	Soft	4	14	33.0	88.6	5-LS: Uniform, very fine texture. Silty blue clay.
6-LS	563.0	Soft	3	12	28.9	94.8	6-LS: Uniform, very fine texture. Silty blue clay with pebbles.
7-LS	558.0	Soft	3	12	35.3	86.1	7-LS: Uniform, very fine texture. Silty blue clay.
8-LS	553.0	Soft	3	12	35.2	86.4	8-LS: Uniform, very fine texture. Smooth silty blue clay with pebbles.
9-LS	548.0	Soft	3	12	32.5	90.5	9-LS: Uniform, very fine texture. Silty blue clay.
10-LS	543.0	Soft	3	12	31.8	92.4	10-LS: Uniform, very fine texture. Silty blue clay.
11-LS	538.0	Soft to Plastic	4	13	44.2	78.6	11-LS: Uniform, very fine texture. Silty blue clay with little sand.
12-LS	533.0	Soft to Plastic	4	12	39.6	81.1	12-LS: Uniform, very fine texture. Silty blue clay with little sand.
13-LS	528.0	V.Soft	5	12	29.5	93.0	13-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand & pebs.
14-LS	523.0	V.Soft	6	12	28.5	95.5	14-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
15-LS	518.0	Soft to Plastic	7	12	25.5	98.6	15-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
16-LS	513.0	Soft to Plastic	7	12	29.5	93.0	16-LS: Uniform, very fine texture. Silty blue clay. Little sand. Tr.pebs.Int.voids.
17-LS	508.0	Soft	7	12	20.3	108.0	17-LS: Uniform, fine texture. Silty sandy blue clay with pebbles.
18-LS	503.0	Soft	7	12	29.3	93.0	18-LS: Uniform, fine texture. Silty sandy blue clay with pebs. Int. voids.
19-LS	498.0	Soft	7	12	29.0	94.8	19-LS: Uniform, fine texture. Silty sandy blue clay with pebs. Int. voids.
20-LS	493.0	V.Soft	8	13	23.6	92.2	20-LS: Uniform, fine texture. Silty sandy blue clay with pebbles.
	488.0	- -	10	12			
21-LS	486.0	Plastic	12	12	19.9	111.7	21-LS: Uniform, fine texture. Blue clay. Some silt. Little sand. Tr. pebs.
22-LS	481.0	Soft	7	12	29.1	91.7	22-LS: Uniform, fine texture. Silty blue clay. Some sand.Tr.pebbles. Int. voids.
23-LS	476.0	Soft to Plastic	8	12	29.6	92.4	23-LS: Uniform, fine texture. Silty blue clay. Some sand.Tr.pebbles. Int. voids.
24-LS	471.0	Soft to Plastic	6	12	35.4	81.1	24-LS: Uniform, fine texture. Silty blue clay with little sand. Int. voids.
25-LS	466.0	Soft	8	12	34.2	86.1	25-LS: Uniform, very fine texture. Silty blue clay with internal voids.
26-LS	459.6	Weakly Coherent	16	12			
			180	12	13.9	- -	26-LS: Uniform, very fine texture. Fine to med. gray sand. Some clay. Tr. pebs.
	457.1	- -	225	5			
	455.1	- -	200	3			

▭ Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. [illegible].

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



○——○ TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

●——● ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

⊗ TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE AS INDICATED.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 5
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

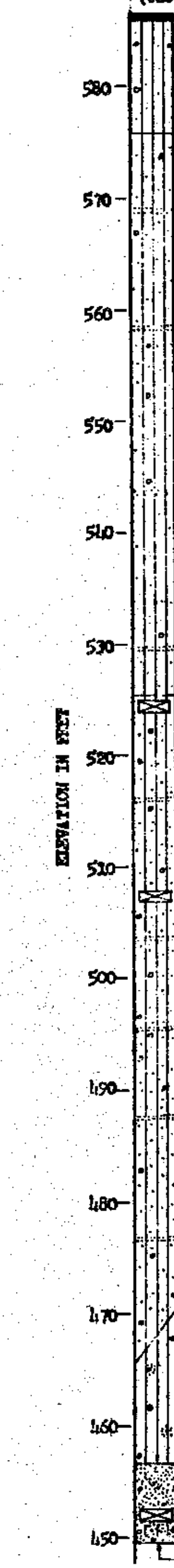
APPROVED: W.S. Housel DATE: 2-3-5?

UNIVERSITY OF MICHIGAN PROJECT 2373-?

LOG OF SOIL PROFILE

BY RCPCo VISUAL INSPECTION

GROUND SURFACE ELEVATION = 586.5' (USC & GS DATUM)



Topsoil.

Hard Vari-Colored Clay, Trace of Sand & Gravel.

Soft Blue Clay, Trace of Sand & Gravel, Few Seams of Sand.

Few Sand Inclusions and Seams.

Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.

Medium Blue Clay, Some Sand Inclusions, Trace of Gravel.

Hardpan; Fine to V.Fine Grey Sand, Tr.of Grav.

Hardpan; Compact Clayey Fine Gray Sand, Little Gravel.

Refusal.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	583.5	Hard	10	12	23.0	103.0	1-LS: Uniform, fine texture. Vari-colored clay with trace of gravel.
2-LS	578.5	Hard	19	12	24.3	103.0	2-LS: Uniform, very fine texture. Vari-colored clay with little silt.
3-LS	574.5	Soft to Plastic	6	12	30.9	94.2	3-LS: Uniform, very fine texture. Blue clay with little silt.
4-LS	569.5	Soft	3	12	33.9	88.6	4-LS: Uniform, very fine texture. Blue clay with little silt.
5-LS	564.5	Soft	3	12	36.0	87.4	5-LS: Uniform, very fine texture. Blue clay with little silt.
6-LS	559.5	Soft	3	12	33.3	89.2	6-LS: Uniform, very fine texture. Blue clay with little silt.
7-LS	554.5	Soft	3	12	37.5	84.2	7-LS: Uniform, very fine texture. Blue clay with little silt.
8-LS	549.5	Soft	3	12	33.9	89.3	8-LS: Uniform, very fine texture. Silty blue clay.
9-LS	544.5	Soft	3	12	37.0	86.7	9-LS: Uniform, very fine texture. Silty blue clay.
10-LS	539.5	Soft	3	12	46.6	74.3	10-LS: Uniform, very fine texture. Silty blue clay with silt inclusions.
11-LS	534.5	Soft	3	12	36.0	83.0	11-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand.
12-LS	529.5	Soft	3	12	43.4	77.6	12-LS: Uniform, very fine texture. Blue clay with little silt and silt inclusions
	523.5	- -	5	12			
13-LS	522.5	Soft to Plastic	6	12	31.2	92.4	13-LS: Uniform, very fine texture. Silty blue clay with little sand.
14-LS	517.5	Soft to Plastic	6	12	24.7	101.1	14-LS: Uniform, very fine texture. Silty blue clay with little sand.
15-LS	512.5	Plastic	8	12	23.9	102.3	15-LS: Uniform, very fine texture. Silty blue clay with silt inclusions.
	507.5	- -	7	12			
16-LS	505.5	Soft	7	12	29.0	94.2	16-LS: Uniform, fine texture. Silty blue clay with pebbles. Int. voids.
17-LS	500.5	Soft	7	12	31.4	89.2	17-LS: Uniform, very fine texture. Blue clay with some silt and sand.
18-LS	494.5	Soft to Plastic	8	12	26.8	94.2	18-LS: Uniform, very fine texture. Blue clay with some silt and sand.
19-LS	490.5	Soft to Plastic	10	12	26.9	93.6	19-LS: Uniform, very fine texture. Blue clay with some silt and sand. Tr. pebs.
20-LS	485.5	V.Soft	10	12	28.3	91.7	20-LS: Uniform, very fine texture. Blue clay with little silt & sand. Tr. pebs.
21-LS	480.5	Soft to Plastic	11	12	29.0	93.0	21-LS: Uniform, very fine texture. Blue clay with little silt & sand. Tr. pebs.
22-LS	475.5	Soft to Plastic	10	12	17.8	111.7	22-LS: Uniform, fine texture. Blue clay with little silt & sand. Int. voids.
23-LS	470.5	Plastic	8	12	30.3	89.9	23-LS: Uniform, fine texture. Blue clay with little silt & sand.
24-LS	465.5	Plastic	7	12	26.4	- -	24-LS: Uniform, fine texture. Silty blue clay with some sand. Int. voids.
25-LS	460.5	Soft	8	12	15.8	114.2	25-LS: Uniform, very fine texture. Silty blue clay with some sand.
26-LS	455.5	Non.C.	6 75	12 12	15.1	114.8	26-LS: Uniform, very fine texture. Fine gray sand and silt.
27-BS	451.3	V.Hard	200	8	- -	- -	27-BS: Uniform, very fine texture. Silty sandy dark blue clay. Silt partings.

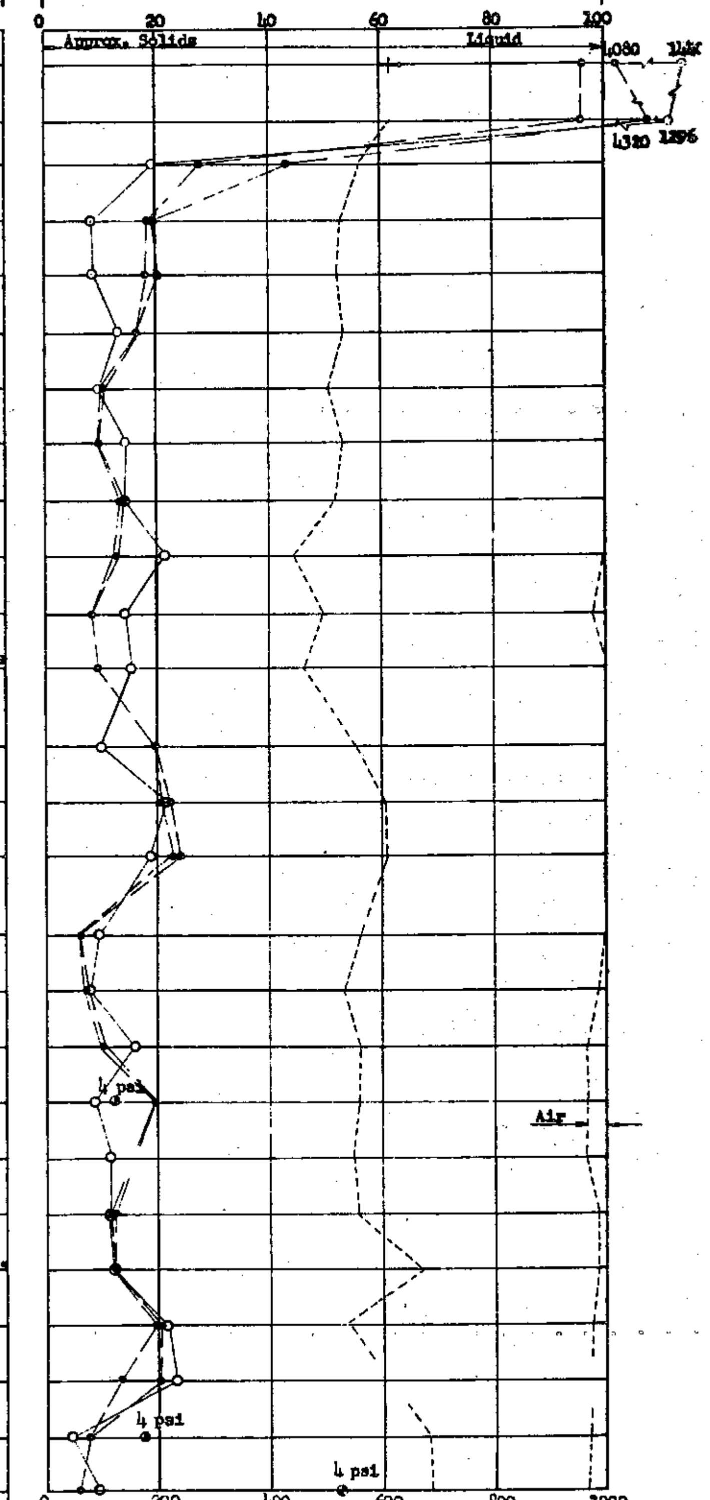
Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT BY VOLUME OF SOILS, LIQUIDS, AND AIR



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN

TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE 4 psi.

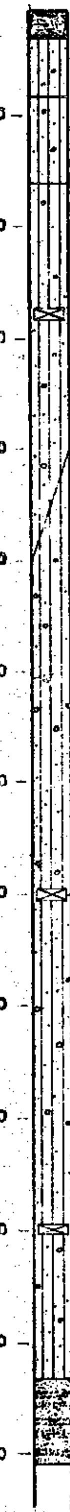
ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 6
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W. O. Housel DATE: 12-13-52

LOG OF SOIL PROFILE BY RCPCo VISUAL INSPECTION GROUND SURFACE ELEVATION = 579.2 (USC & GS DATUM)
Topsoil.
Hard Vari-Colored Clay, Trace of Sand & Gravel.
Soft Yellow Clay, Trace of Sand & Gravel.
Soft Blue Clay, Trace of Sand & Gravel.
Soft Blue Clay, Little Sand & Gravel.
Hardpan; Compact Fine Gray Sand & Seams of Clayey Sand & Shale Chips.
Boring Stopped.

ELEVATION IN FEET: 570, 560, 550, 540, 530, 520, 510, 500, 490, 480, 470, 460, 450



SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	575.2	Firm	12	12			1-LS: Uniform, very fine texture. V. smooth vari-colored clay with little silt.
2-LS	570.2	Firm	3	14			2-LS: Uniform, very fine texture. V. smooth, silty yellow clay.
3-LS	562.2	Plastic	3	13			3-LS: Uniform, very fine texture. Smooth blue clay with little silt.
	552.2	- -	2	15			
4-LS	547.2	Soft	4	12			4-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
5-LS	540.2	Soft to Plastic	2	12			5-LS: Uniform, very fine texture. Smooth silty blue clay with tr. sand & pebbles.
6-LS	530.2	Soft	3	12			6-LS: Uniform, very fine texture. Smooth silty blue clay with tr. sand & pebbles.
7-LS	520.2	Soft to Plastic	3	12			7-LS: Uniform, very fine texture. Smooth blue clay. Some silt, little sand, tr. pebs.
8-LS	510.2	Soft to Plastic	4	12			8-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
	500.2	- -	3	12			
9-LS	497.2	Plastic	5	12			9-LS: Uniform, very fine texture. Blue clay with some silt. Trace sand.
10-LS	488.2	Soft to Plastic	6	12			10-LS: Uniform, very fine texture. Smooth silty blue clay. Little sand.
11-LS	480.2	Soft to Plastic	6	12			11-LS: Uniform, very fine texture. Smooth silty blue clay. Little sand.
	470.2	- -	10	12			
12-LS	467.2	Plastic	9	12			12-LS: Uniform, very fine texture. Smooth silty blue clay. Little sand.
13-LS	457.4	Weakly Coherent	17	12			13-LS: Non-uniform, very fine texture. Varies from sdy. silty gray cl. to f. gray sd.
14-LS	45[illegible]	Plastic to Firm	46	12			14-LS: Uniform, v. fine to fine texture. V. dark gray silty clay. Some sd. & grav.

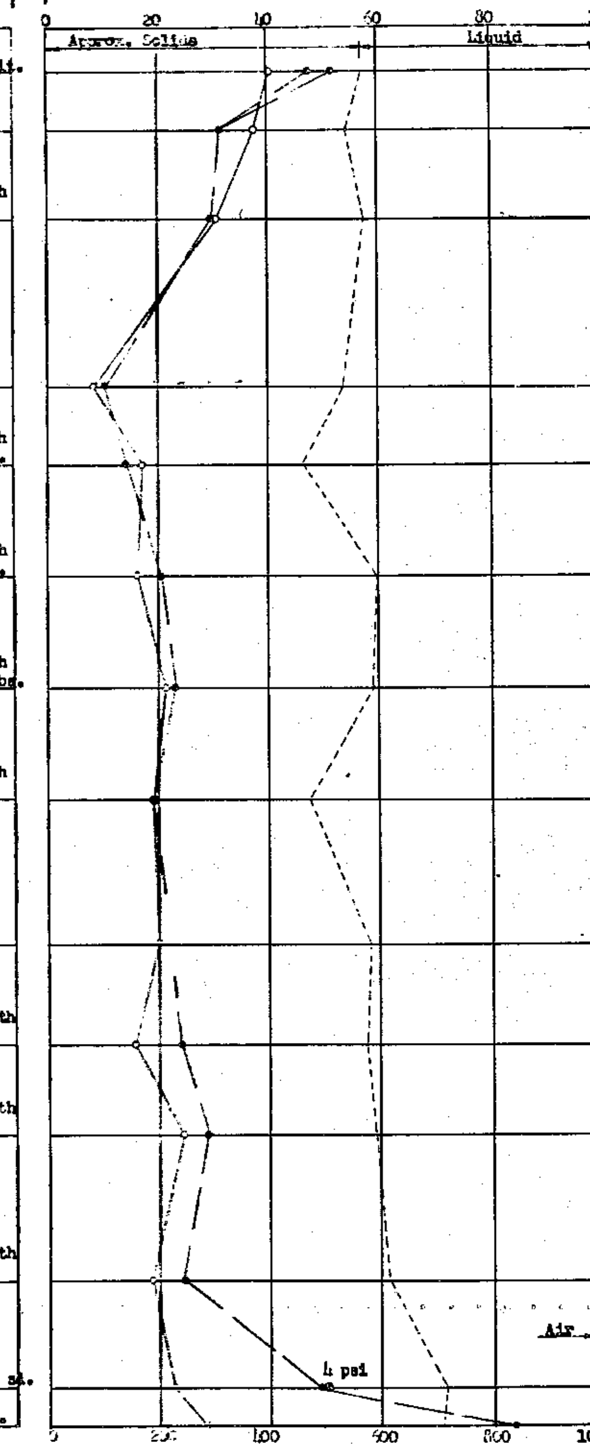
⊠ Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-F.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT OF VOLUME OF SOLIDS, LIQUIDS, AND AIR



o———o TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

o— —o ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

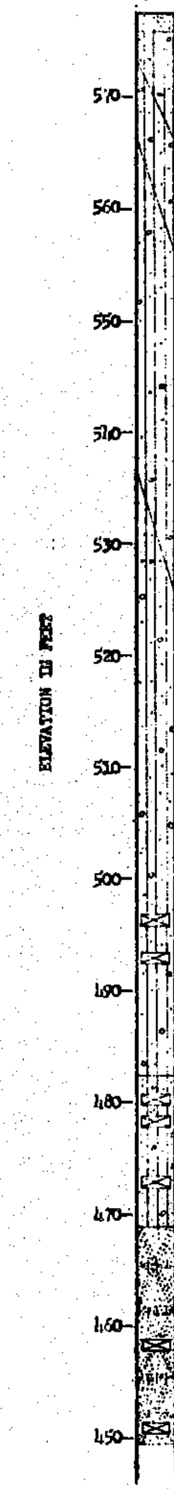
• TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 3 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY
APPROVED: W.C. House DATE: 12-[illegible]-5[illegible]

UNIVERSITY OF MICHIGAN PROJECT M373-5[illegible]

LOG OF SOIL PROFILE

BY RCPCo VISUAL INSPECTION
GROUND SURFACE ELEVATION = 577.6'
(USC & GS DATUM)



- Fine Brown Sand.
- Hard Vari-Colored Clay, Trace of Sand & Gravel.
- Soft Yellow Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Little Sand & Gravel.
- Foreman Reports Sandy Clay with Some Gravel.
- Hardpan; Compact Fine Gray Sand, Seams of Clayey Sand with Some Gravel.
- Boring Stopped.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

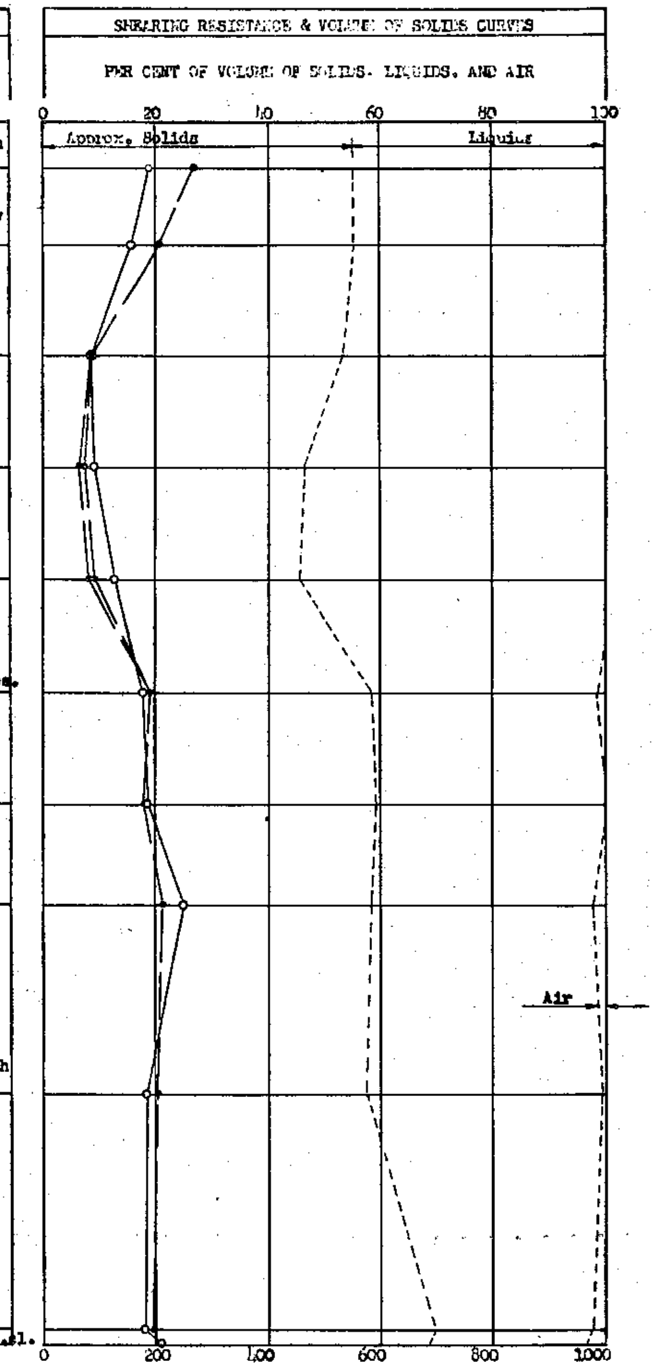
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-LS	573.6	Plastic	6	12	29.8	93.0	1-LS: Uniform, very fine texture. Smooth vari-colored clay with little silt.
2-LS	563.6	Soft	3	12	30.4	93.6	2-LS: Uniform, very fine texture. Yellow clay with little silt. Tr. sand & pebs.
3-LS	556.6	V.Soft	2	12	33.0	89.9	3-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
4-LS	546.6	V.Soft	2	12	43.0	78.6	4-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
5-LS	536.6	Soft	2	14	45.4	76.8	5-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
6-LS	526.6	Soft	5	12	25.5	98.0	6-LS: Uniform, very fine texture. Blue clay with some silt, little sd.Sl.tr.pebs.
7-LS	516.6	Soft	5	12	25.8	99.8	7-LS: Uniform, very fine texture. Silty blue clay with little sand.
8-LS	507.6	Plastic	4	12	25.0	98.0	8-LS: Uniform, very fine texture. Silty blue clay with little sand.
	496.6	- -	5	12			
	493.6	- -	4	12			
9-LS	490.6	Plastic	7	12	27.0	96.7	9-LS: Uniform, very fine texture. Smooth blue clay with some silt.
	480.6	- -	10	12			
	478.6	- -	10	12			
	473.6	- -	10	12			
10-LS	469.6	Plastic	21	10	15.0	116.7	10-LS: Uniform, very fine texture. Blue clay with little silt and sand.
11-LS	468.4	N.C.	58	12	15.3	114.8	11-LS: Unif. v.f.text.Gray silty vfs.Tr.cl.
12-SS	458.6	- -	56	12			
13-SS	451.2	- -	89	12			

[symbol] Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-0.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



o———o TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.
0 800 1600 2400 3200 4000
•— —• ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 7
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

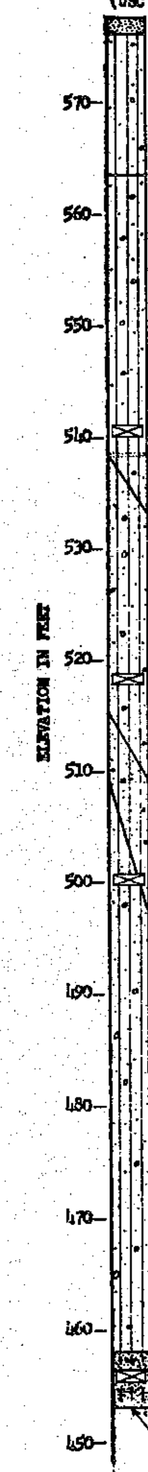
APPROVED: W. J. Gould DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M573-66

LOG OF SOIL PROFILE

BY RCPCo VISUAL INSPECTION

GROUND SURFACE ELEVATION = 577.6' (USC & GS DATUM)



- Brown Sand.
- Medium Vari-Colored Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Trace Sand & Gravel.
- Seam of V. Fine Gray Sand, Tr. of Clay.
- Soft Blue Clay, Little Sand & Gravel.
- Sandy Medium Blue Clay, Some Gravel.
- Soft Blue Clay, Little Sand & Gravel.
- Gas Pocket
- Hardpan; Fine to Med. Gray Sand, Tr. of Clay.
- Hardpan; Compact Clayey F. Gray Sand, Seams of Clean Sand.
- Refusal.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.

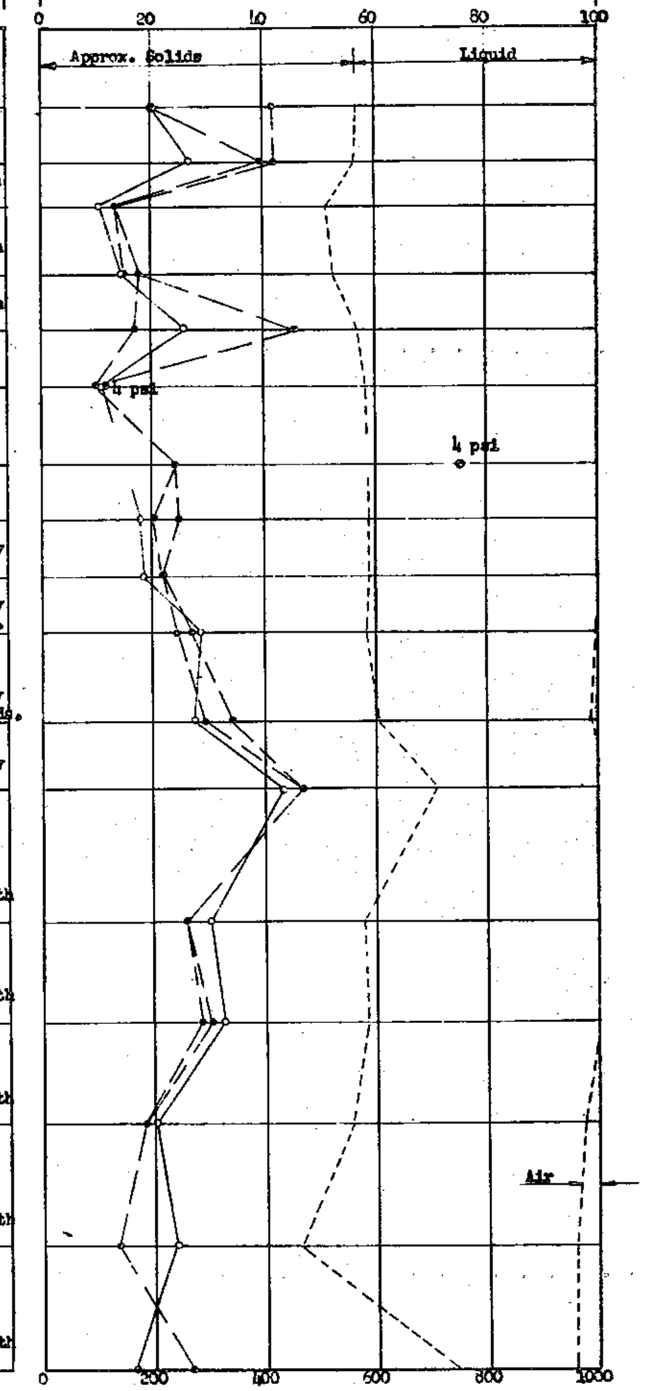
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-BS	574.2	- -	6	12			
2-LS	570.6	Plastic	6	12	29.8	95.5	2-LS: Uniform, very fine texture. Silty vari-colored clay.
3-LS	565.9	Plastic	6	12	31.9	94.2	3-LS: Uniform, very fine texture. Silty vari-colored clay.
4-LS	561.6	Soft	5	12	37.5	86.1	4-LS: Uniform, very fine texture. Smooth silty blue clay.
5-LS	555.6	Soft	3	12	34.4	88.0	5-LS: Uniform, very fine texture. Smooth silty blue clay.
6-LS	550.6	Plastic	3	12	29.4	95.5	6-LS: Uniform, very fine texture. Smooth silty blue clay.
7-LS	545.6	Weakly Coherent	2	14	27.3	97.3	7-LS: Uniform, fine texture. Blue clay with some silt. Little sand.
	540.6	- -	3	12			
8-LS	538.6	Non-Coherent	4	13	20.9	107.3	8-LS: Non-uniform, fine texture. Varies from gray silt to silty gray clay.
9-LS	533.6	Plastic	3	13	25.4	99.2	9-LS: Uniform, very fine texture. Silty blue clay with pebbles.
10-LS	528.6	Plastic	2	12	26.1	99.2	10-LS: Uniform, very fine texture. Silty blue clay with pebbles.
11-LS	523.6	Plastic	3	13	26.2	98.0	11-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
	518.6	- -	4	13			
12-LS	515.6	Plastic	4	14	23.6	101.1	12-LS: Uniform, very fine texture. Silty blue clay. Little sand. Tr.pebs.Int.voids.
13-LS	509.6	Plastic	7	12	16.7	119.2	13-LS: Uniform, very fine texture. Silty blue clay. Little sand.
	500.6	- -	6	12			
14-LS	497.6	Plastic	6	12	26.8	97.3	14-LS: Uniform, very fine texture. Smooth silty blue clay with some silt & sand.
15-LS	488.6	Plastic	6	13	26.4	98.6	15-LS: Uniform, very fine texture. Smooth blue clay. Some silt. Tr. sand & pebs.
16-LS	479.6	Plastic	6	12	27.9	93.6	16-LS: Uniform, very fine texture. Smooth silty blue clay.
17-LS	468.6	Soft to Plastic	4	12	39.6	77.4	17-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
18-LS	457.5	F.Stiff	28	12	10.7	124.8	18-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
19-BS	456.1	- -	160	8	- -	- -	

⊠ Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT OF VOLUME OF SOLIDS, LIQUIDS, AND AIR



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

o——o 0 800 1600 2400 3200 4000

ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

●— —● TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

● UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

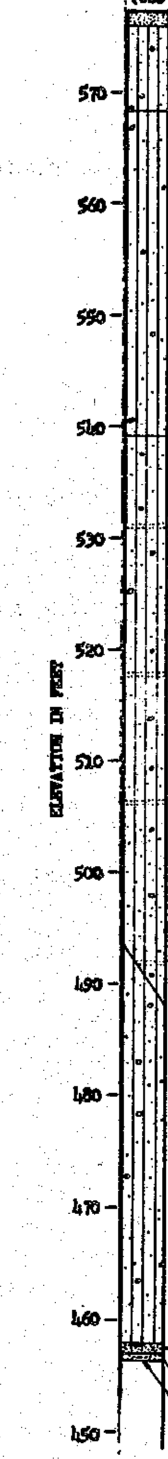
SUBSOIL ANALYSIS OF BORING NO. 9
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.S. Housel DATE 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M373-66

LOG OF SOIL PROFILE
BY RCPCo VISUAL INSPECTION

GROUND SURFACE ELEVATION = 577.2'
(USC & GS DATUM)



Yellow Sand.

Medium Yellow Clay, Trace of Sand & Gravel.

Soft Blue Clay, Trace of Sand & Gravel.

Soft Blue Clay, Little Sand & Gravel, Few Sand Seams.

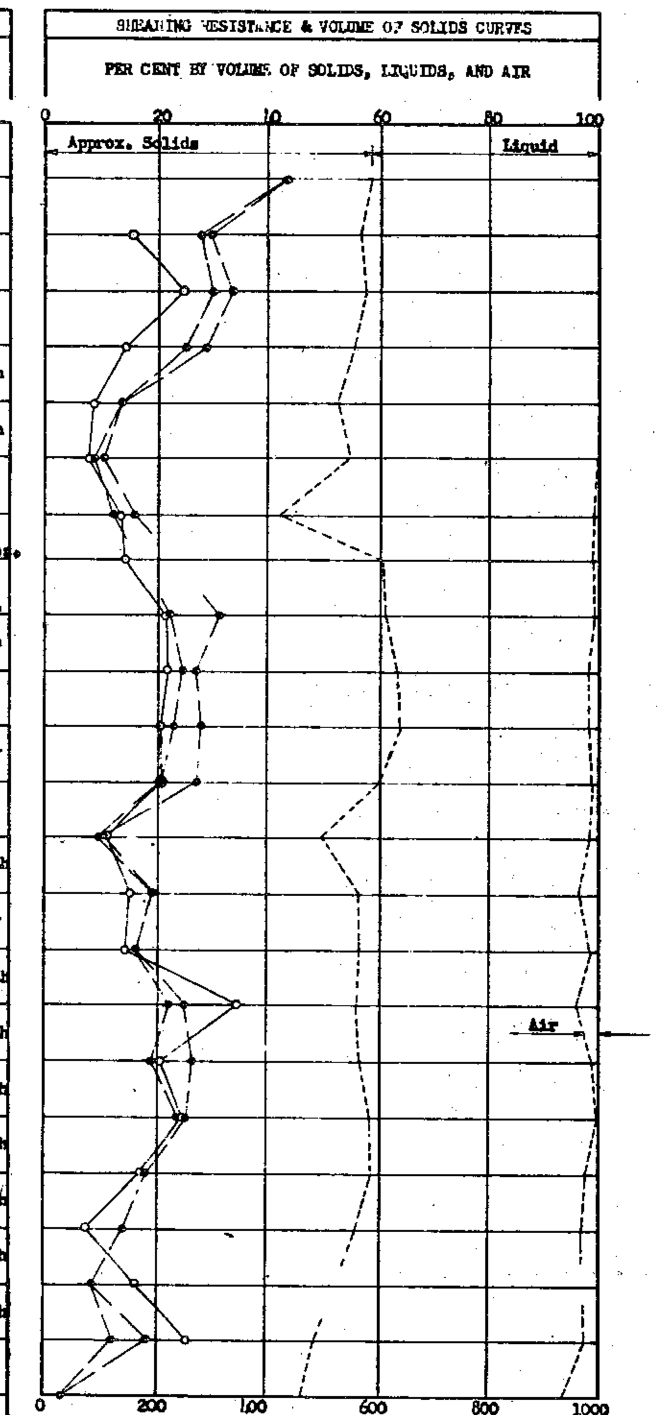
Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.

Comp. Clayey F. Grey Sand, Some Gr. Seams
Clean Sand.
Foreman Reports Sdy. Hard-pan. Refusal.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7459-D.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-BS	573.7	- -	6	12			
2-LS	572.2	Plastic	7	12	26.9	98.6	2-LS: Uniform, very fine texture. Silty yellow clay.
3-LS	567.2	Soft to Plastic	3	12	29.6	94.8	3-LS: Uniform, very fine texture. Silty blue clay.
4-LS	562.2	Plastic	5	12	28.4	96.1	4-LS: Uniform, very fine texture. Silty blue clay.
5-LS	557.2	Soft to Plastic	4	12	30.1	93.0	5-LS: Uniform, very fine texture. Silty blue clay.
6-LS	552.2	Soft	3	14	35.2	87.7	6-LS: Uniform, very fine texture. Smooth silty blue clay.
7-LS	547.2	V.Soft	3	14	31.3	91.1	7-LS: Uniform, very fine texture. Smooth silty blue clay.
8-LS	542.2	Soft	2	12	50.0	70.5	8-LS: Uniform, very fine texture. Blue clay with little silt and sand.
9-LS	538.2	Soft	6	12	23.6	102.1	9-LS: Uniform, very fine texture. Blue clay with little silt. V.f.s.incl.Tr.pebs.
10-LS	533.2	Soft to Plastic	5	13	23.2	102.3	10-LS: Uniform, very fine texture. Blue clay with little silt and sand. Tr.pebs.
11-LS	528.2	Plastic	7	12	20.4	106.1	11-LS: Uniform, fine texture. Silty blue clay with little sand and pebbles.
12-LS	523.2	Plastic	6	12	20.4	106.1	12-LS: Uniform, fine texture. Blue clay with some silt, little sd. & pebbles.
13-LS	518.2	Plastic	6	12	24.2	100.5	13-LS: Uniform, very fine texture. Silty blue clay with little sand.
14-LS	513.2	Soft	5	12	37.4	82.4	14-LS: Uniform, very fine texture. V. smooth silty blue clay.
15-LS	508.2	Soft	5	12	26.8	94.2	15-LS: Uniform, very fine texture. Smooth silty blue clay.
16-LS	503.2	Soft	5	12	27.3	94.8	16-LS: Uniform, very fine texture. Silty blue clay with little sand.
17-LS	498.2	Plastic	5	12	26.5	93.6	17-LS: Uniform, very fine texture. Smooth blue clay with some silt.
18-LS	493.2	Plastic	6	12	27.2	95.5	18-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
19-LS	488.2	Plastic	6	12	26.5	98.0	19-LS: Uniform, very fine texture. Smooth silty blue clay. Little sand. Tr. pebs.
20-LS	483.2	Soft to Plastic	7	12	24.4	98.6	20-LS: Uniform, very fine texture. Smooth silty blue clay.
21-LS	478.2	Soft	7	12	27.2	93.6	21-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.
22-LS	473.2	Soft	8	12	41.7	73.7	22-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.
23-LS	468.2	Plastic	7	12	36.3	81.7	23-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.
24-LS	463.2	V.Soft	7	12	37.7	77.4	24-LS: Uniform, very fine texture. Silty blue clay with some sand. Tr. pebbles.
25-BS	455.7	- -	150 56	9 1			

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.
0 800 1600 2400 3200 4000
ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 10
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

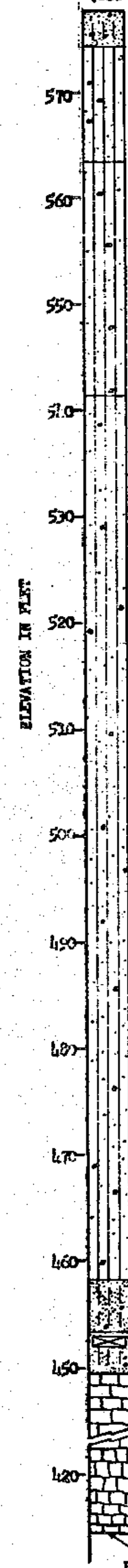
APPROVED: W. K. Toukel DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M373-66

LOG OF SOIL PROFILE

BY RCPCo VISUAL INSPECTION
GROUND SURFACE
ELEVATION = 577.6'
(USC & GS DATUM)

ELEVATION IN FEET



F. to Med. Gray Sand, Little Gravel & Silt.

Medium Yellow Clay, Trace of Sand & Gravel.

Soft Blue Clay, Trace of Sand & Gravel.

Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.

Hardpan; Comp. Fine Gray Sand, Little Clay & Gravel.

Hardpan; Comp. Clayey Sand & Shale Chips, Seams of Clean Sand, Few Small Boulders.

Probably Fractured Blue Shale.

Refusal.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. 8-7453-L.

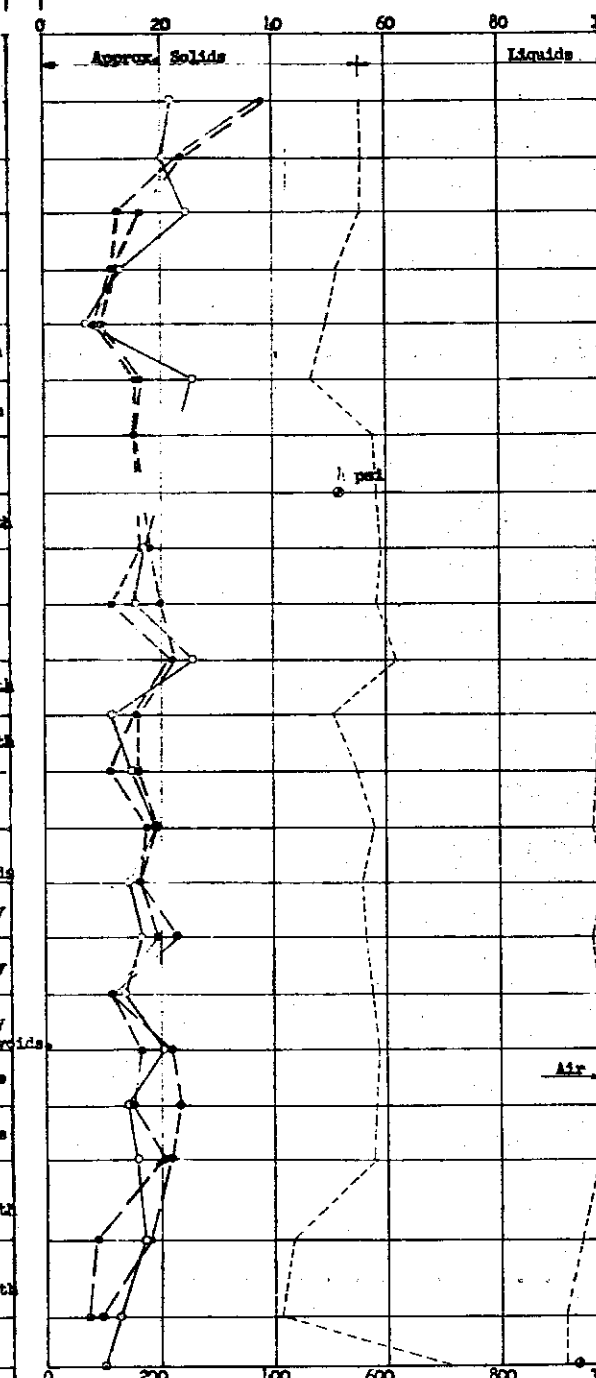
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-BS	574.1	- -	5	12			
2-BS	572.6	- -	7	12			
3-LS	571.6	Plastic	7	12	28.8	93.6	3-LS: Uniform, very fine texture. V. smooth yellow clay with little silt.
4-LS	566.6	Plastic	5	12	29.5	94.2	4-LS: Uniform, very fine texture. V. smooth silty yellow clay.
5-LS	561.6	Plastic	4	12	31.3	93.6	5-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
6-LS	556.6	Soft	3	14	36.5	86.1	6-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
7-LS	551.6	Soft	3	14	38.5	83.0	7-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
8-LS	546.6	Soft to Plastic	2	12	44.2	78.6	8-LS: Uniform, very fine texture. Smooth silty blue clay.
9-LS	541.6	Soft	6	12	27.6	96.1	9-LS: Uniform, very fine texture. Smooth silty blue clay.
10-LS	536.6	Weakly Coherent	7	12	26.2	96.1	10-LS: Uniform, very fine texture. Clayey blue silt and v.f. sand.
11-LS	531.6	Soft to Plastic	5	12	24.2	99.2	11-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. sand.
12-LS	526.6	Soft to Plastic	6	12	24.9	98.6	12-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand.
13-LS	521.6	Plastic	6	12	23.2	103.6	13-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand.
14-LS	516.6	Soft	5	12	34.0	85.5	14-LS: Uniform, very fine texture. Smooth silty blue clay.
15-LS	511.6	Soft	5	12	28.8	92.4	15-LS: Uniform, very fine texture. Smooth silty blue clay.
16-LS	506.6	Soft to Plastic	6	12	24.9	97.3	16-LS: Uniform, very fine texture. Blue clay with some silt. Internal voids.
17-LS	501.6	Soft	5	12	28.4	93.9	17-LS: Uniform, very fine texture. Blue clay with some silt & pebbles. Int. voids
18-LS	496.6	Soft to Plastic	8	12	26.7	94.2	18-LS: Uniform, very fine texture. Silty blue clay with some sand. Int. voids.
19-LS	491.6	Soft	9	12	26.3	96.1	19-LS: Uniform, very fine texture. Silty blue clay with some sand. Int. voids.
20-LS	486.6	Soft to Plastic	9	12	25.8	97.3	20-LS: Uniform, very fine texture. Silty blue clay with some silt, little sd. Int. voids.
21-LS	481.6	Plastic	10	12	25.7	97.3	21-LS: Uniform, fine texture. Silty blue clay. Little sand and pebbles.
22-LS	476.6	Plastic	10	12	25.9	95.5	22-LS: Uniform, fine texture. Silty blue clay with some sand and pebbles.
	471.6	- -	9	12			
23-LS	469.6	Soft	8	12	43.6	73.0	23-LS: Uniform, very fine texture. Smooth colloidal blue clay. Internal voids.
	464.6	- -	8	12			
24-LS	462.6	Soft	7	12	45.1	69.3	24-LS: Uniform, very fine texture. Smooth colloidal blue clay. Internal voids.
25-LS	458.1	Very Weakly Coherent	145	12	10.9	119.2	25-LS: Uniform, very fine texture. Gray silt and very fine sand. Some clay.
26-BS	452.6	V. Hard	170	12	- -	- -	26-BS: Uniform, very fine texture. V. silty dark blue clay. Some sand & pebs.

[X] Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT BY VOLUME OF SOLIDS, LIQUIDS, AND AIR



0 800 1600 2400 3200 4000

o———o TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

●— — —● ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

⊙ TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 11 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY
APPROVED: W.S. Housel DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT M373-56

LOG OF SOIL PROFILE
BY RCPCo VISUAL INSPECTION
GROUND SURFACE ELEVATION = 580.2'
(USC & GS DATUM)

Elev.	Soil profile
580	Topsoil.
	F. Silty Sd., Little Veg.
	Med. Gray Sd., Little Silt.
	Medium Yellow Clay, Trace of Sand & Gravel.
570	
560	Soft Blue Clay, Trace Sand & Gravel.
550	
540	
530	
520	
510	Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.
500	
490	
480	
470	
460	Hardpan; Comp. Fine Gray Sand, Little Grav. & Clay.
	Refusal.
450	

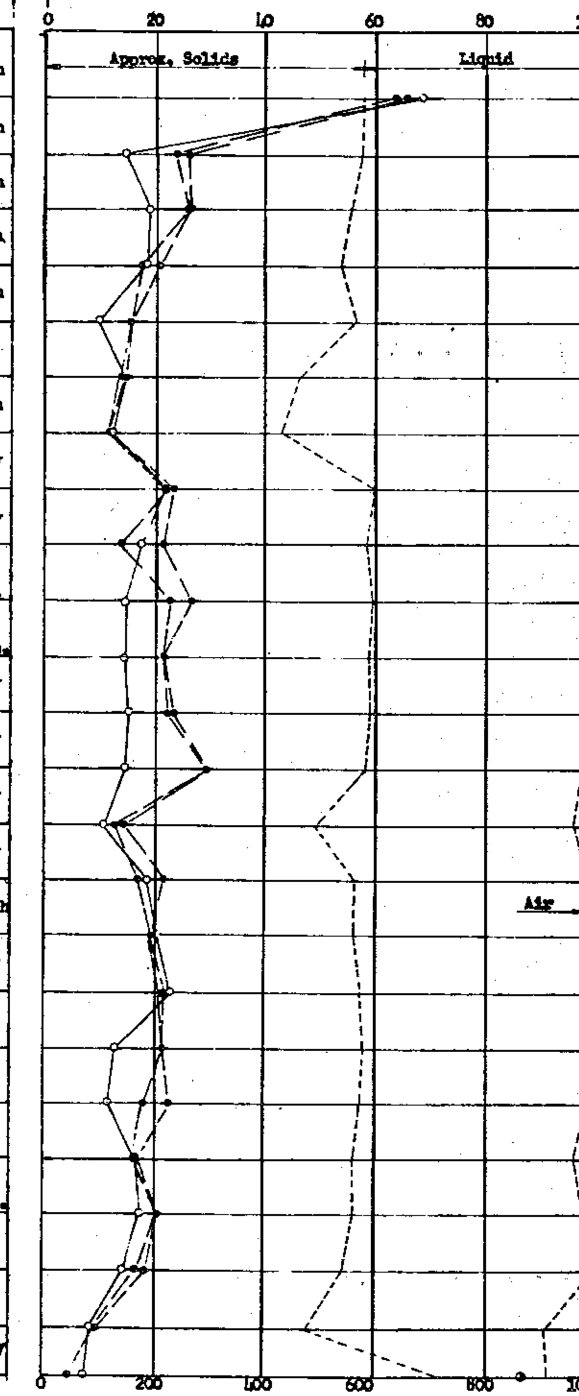
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-SS	576.7	--	5	12			
2-SS	575.4	--	6	12			
3-LS	574.2	Firm	10	12	27.2	97.3	3-LS: Uniform, very fine texture. Smooth silty yellow clay.
4-LS	569.2	Plastic	6	12	28.5	96.7	4-LS: Uniform, very fine texture. Smooth silty blue clay.
5-LS	564.2	Plastic	4	12	30.2	93.0	5-LS: Uniform, very fine texture. Smooth silty blue clay.
6-LS	559.2	Soft	3	12	33.2	90.5	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	554.2	Soft	3	14	29.4	94.5	7-LS: Uniform, very fine texture. Smooth blue clay with little silt.
8-LS	549.2	Soft	3	14	42.4	77.4	8-LS: Uniform, very fine texture. Silty blue clay.
9-LS	544.2	Soft	2	12	48.9	72.1	9-LS: Uniform, very fine texture. Smooth blue clay with some silt.
10-LS	539.2	Soft to Plastic	5	12	24.4	100.5	10-LS: Uniform, very fine texture. Silty blue clay with little sand and pebbles.
11-LS	534.2	Soft to Plastic	5	12	25.3	98.6	11-LS: Uniform, very fine texture. Silty blue clay with pebbles.
12-LS	529.2	Soft to Plastic	5	12	23.9	99.8	12-LS: Uniform, very fine texture. Blue clay with little silt and sand. Tr.pebs.
13-LS	524.2	Plastic	6	12	25.0	98.9	13-LS: Uniform, very fine texture. Blue clay with some silt. Little sand.Tr.pebs.
14-LS	519.2	Plastic	6	12	25.7	99.2	14-LS: Uniform, very fine texture. Silty blue clay with pebbles.
15-LS	514.2	Soft to Plastic	6	12	24.5	98.6	15-LS: Uniform, very fine texture. Silty blue clay with some sand. Tr. pebs.
16-LS	509.2	Soft to Plastic	6	12	34.9	83.0	16-LS: Uniform, very fine texture. Silty blue clay with some sand. Int. voids.
17-LS	504.2	Soft to Plastic	6	12	27.7	94.8	17-LS: Uniform, very fine texture. Silty blue clay. Internal voids.
18-LS	499.2	Soft to Plastic	7	12	27.6	94.3	18-LS: Uniform, very fine texture. Smooth silty blue clay, some sand. Tr. pebbles.
19-LS	494.2	Plastic	6	12	26.8	96.7	19-LS: Uniform, very fine texture. Silty blue clay.Little sand.Tr.pebs.Int.voids.
20-LS	489.2	Soft to Plastic	6	12	27.7	97.3	20-LS: Uniform, very fine texture. Blue clay with some silt and little sand.
21-LS	484.2	Soft to Plastic	7	12	26.5	96.1	21-LS: Uniform, very fine texture. Blue clay with some silt.Little sd.Int.voids.
22-LS	479.2	Soft to Plastic	7	12	26.6	94.2	22-LS: Uniform, very fine texture. Blue clay with little silt and sand.
23-LS	474.2	Soft to Plastic	7	12	26.8	94.2	23-LS: Uniform, very fine texture. Blue clay with little silt and sand.Int.voids.
24-LS	469.2	Soft	6	12	30.5	91.1	24-LS: Uniform, very fine texture. Blue clay with little sand & silt.
25-LS	464.2	Soft	6	12	34.5	79.2	25-LS: Uniform, very fine texture. Silty blue clay with some sand. Int. voids.
26-LS	459.8	Weakly Coherent	10 / 100	12 / 10	10.1	120.4	26-LS: Uniform, very fine texture. Clayey silt and grey very fine to fine sand.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. D-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT BY VOLUME OF SOLIDS, LIQUIDS, AND AIR



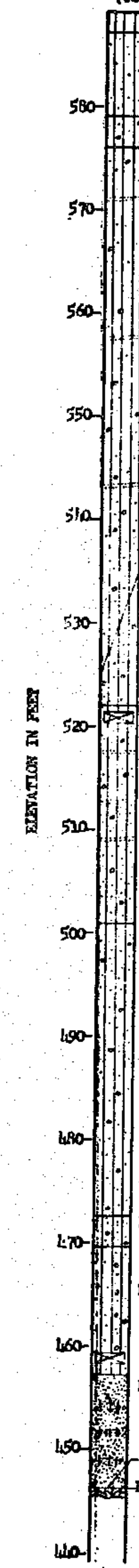
TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.
0 800 1600 2400 3200 4000
ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.
TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE 4 psi.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 12
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.C. Housel DATE: 12-13-50
UNIVERSITY OF MICHIGAN PROJECT M273-56

LOG OF SOIL PROFILE BY RCPCo VISUAL INSPECTION
GROUND SURFACE ELEVATION = 589.0' (USC & GS DATUM)
Med. Vari-colored Clay.
Hard Vari-Colored Clay, Trace Sand.
Med. Hard Blue Clay, Trace of Sand & Gravel.
Soft Blue Clay, Trace of Sand & Gravel, Few Sand Seams.
Soft Blue Clay, Little Sand & Gravel.
Soft Blue Clay, Some Sand & Gravel, Few Sand Seams.
Soft Blue Clay, Little Sand & Gravel.
Med. Hard Blue Clay, Some Sand, Little Gr.
Medium Blue Clay, Trace of Sand & Gravel.
Hardpan; Compact Fine Gray Sand, Seams of Clayey Sand & Shale.
Broken Shale.
Boring Stopped.



SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-DS	585.5	- -	18	12			
2-LS	584.0	Hard	17	12	23.5	103.0	2-LS: Uniform, very fine texture. Smooth vari-colored clay with little silt.
3-LS	579.0	Plastic to Firm	14	12	26.4	101.1	3-LS: Uniform, very fine texture. Smooth blue clay with little silt. Sl. tr. pebbles.
4-LS	575.0	Soft	4	13	32.2	91.7	4-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. v. f. s.
5-LS	565.0	Soft	4	12	33.6	88.9	5-LS: Uniform, very fine texture. Smooth silty blue clay. Sl. tr. of pebbles.
6-LS	555.0	Soft	3	13	40.4	81.1	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	545.0	Soft	3	13	43.5	79.2	7-LS: Uniform, very fine texture. Smooth blue clay with little silt.
8-LS	535.0	Soft	3	13	44.6	77.4	8-LS: Uniform, very fine texture. Smooth blue clay with little silt.
9-LS	525.0	V. Soft	5	12	27.5	98.0	9-LS: Uniform, very fine texture. Silty blue clay with little sand.
	521.0	- -	8	12			
10-LS	519.0	Soft	8	12	22.1	103.6	10-LS: Uniform, very fine texture. Silty blue clay with little sand.
11-LS	509.0	Plastic	11	12	20.1	106.1	11-LS: Uniform, very fine texture. Smooth silty blue clay. Trace of sand.
12-LS	500.0	Soft	7	12	28.4	96.7	12-LS: Uniform, very fine texture. Smooth silty blue clay. Trace of sand.
13-LS	490.0	Soft	8	12	28.6	96.7	13-LS: Uniform, very fine texture. Smooth silty blue clay. Trace of sand.
14-LS	480.0	Soft to Plastic	8	12	39.2	79.9	14-LS: Uniform, very fine texture. V. smooth blue clay with little silt.
15-LS	471.7	Plastic	24	12	17.5	112.6	15-LS: Uniform, very fine texture. Blue clay with little silt and sand.
16-LS	469.0	Soft	10	12	30.0	91.1	16-LS: Uniform, very fine texture. Smooth blue clay with little silt.
	459.0	- -	15	12			
17-LS	457.0	Sandy Coherent	108	12	8.3	111.1	17-LS: Uniform, fine texture. Clayey fine to medium gray sand.
18-LS	452.0	Hard	140	12	- -	- -	18-LS: Uniform, very fine texture. Silty dark blue clay.
19-DS	446.8	- -	200	5	- -	- -	

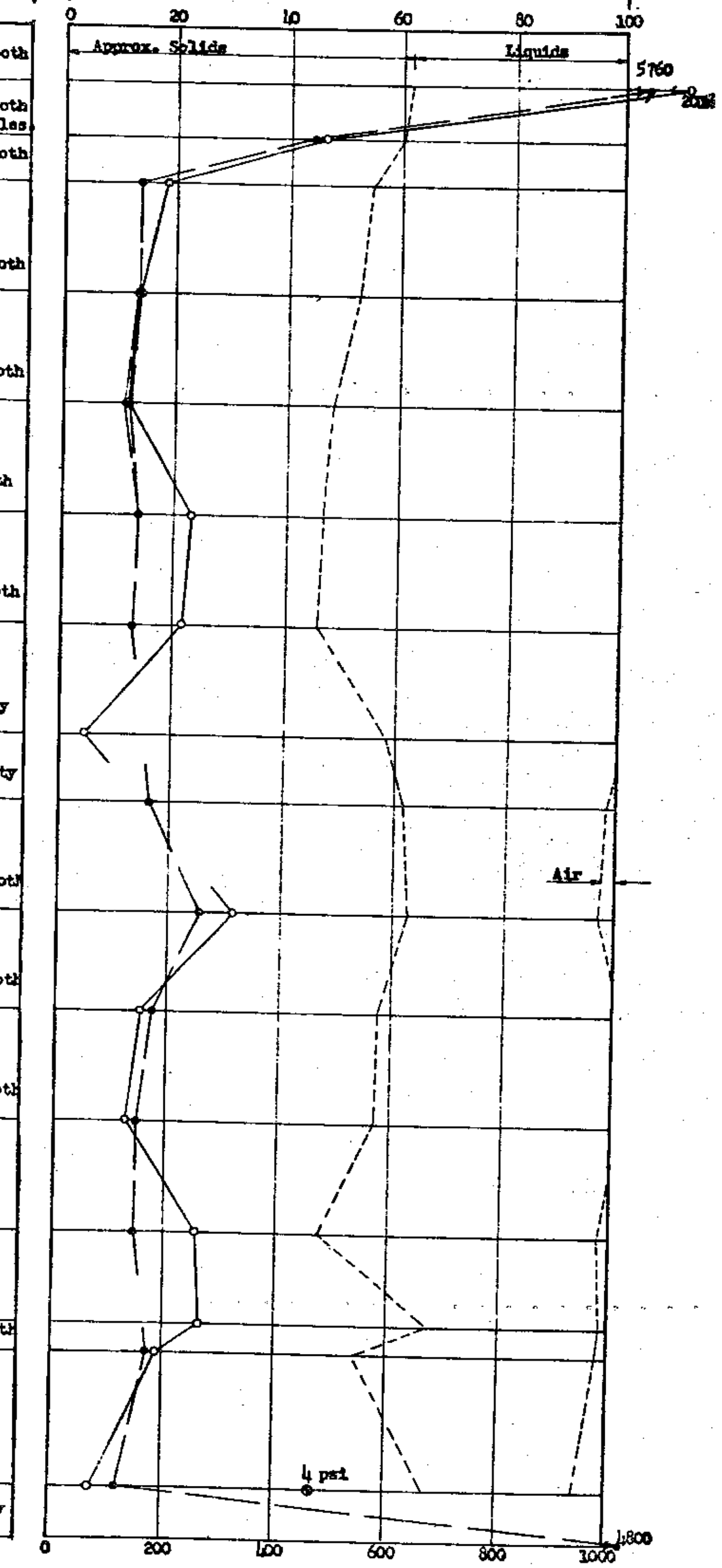
⊠ Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT OF VOLUME OF SOLIDS, LIQUIDS, AND AIR



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

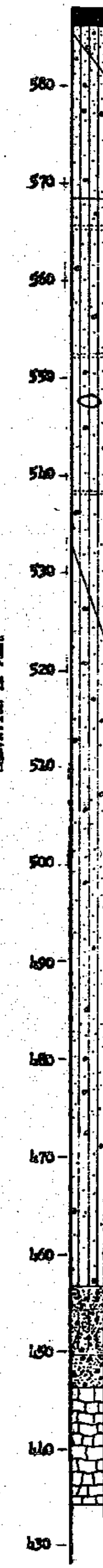
ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 13 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY

LOG OF SOIL PROFILE

BY RCPCo. VISUAL INSPECTION
GROUND SURFACE
ELEVATION = 588.1'
(USC & GS DATUM)



Topsoil.
Hard Vari-Colored Clay, Little Sand & Gravel.

Medium Yellow Clay, Trace Sand & Gravel.

Soft Blue Clay, Trace Sand & Gravel, Few Sand Seams.

Boulder.

Soft Blue Clay, Little Sand & Gravel.

Hardpan; Clayey Med. Gray Sd., Some Gravel & Sand, Shale Chips, Seams of Clean Sand.

Hardpan; Broken Shale Fractured Seamy Soft Blue Shale.

Cored	Recovered
4'7"	2'9"
5'0"	3'6"
3'11"	2'10"

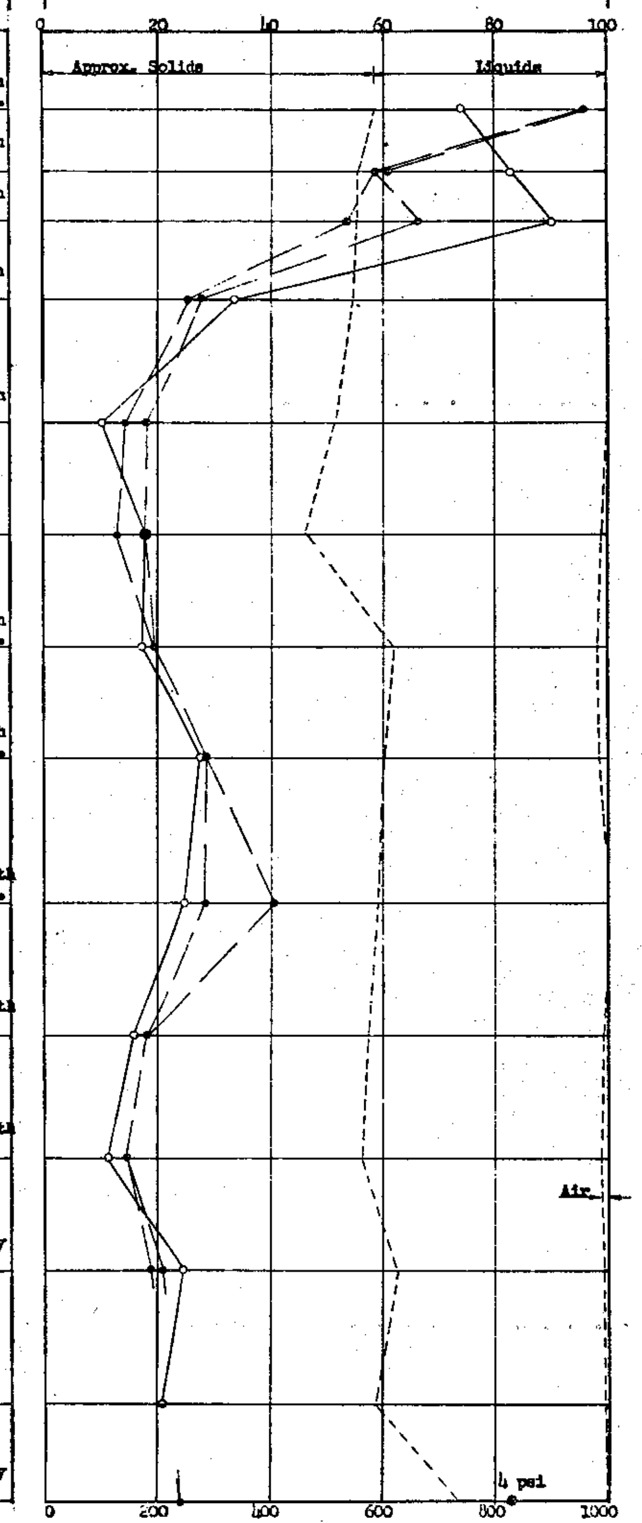
Boring Stopped.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. R-7453-D.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-DS	585.6	- -	27	12			
2-LS	581.1	Stiff	11	12	26.6	98.6	2-LS: Uniform, very fine texture. Smooth var-colored clay with little silt. Tr. sd.
3-LS	575.6	Firm to Stiff	7	12	30.4	93.0	3-LS: Uniform, very fine texture. Smooth yellow clay with little silt. Tr. sd.
4-LS	571.1	Stiff	9	13	31.2	93.0	4-LS: Uniform, very fine texture. Smooth yellow clay with little silt. Tr. sd.
5-LS	564.1	Plastic	7	12	31.4	91.7	5-LS: Uniform, very fine texture. Smooth silty blue clay with tr. sand.
6-LS	553.1	Soft	3	14	35.2	86.1	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	543.1	Soft	3	14	42.9	77.4	7-LS: Uniform, very fine texture. Blue clay with some silt and little sand.
8-LS	533.1	Soft	5	12	21.8	104.2	8-LS: Uniform, very fine texture. Smooth blue clay with little silt and tr. sand.
9-LS	523.1	Plastic	7	12	23.8	100.5	9-LS: Uniform, very fine texture. Smooth blue clay with little silt and tr. sand.
	513.1	- -	9	12			
10-LS	510.1	Plastic	10	12	26.4	98.6	10-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. sd. & pebs.
	500.1	- -	7	12			
11-LS	498.1	Soft	7	12	27.1	96.1	11-LS: Uniform, very fine texture. Smooth blue clay with some silt.
12-LS	487.1	Soft	7	12	28.0	94.8	12-LS: Uniform, very fine texture. Smooth silty blue clay.
13-LS	477.1	Soft to Plastic	7	12	21.7	105.5	13-LS: Uniform, very fine texture. Silty blue clay with little sand.
	467.1	- -	7	12			
14-LS	465.1	Plastic	7	12	26.1	98.6	14-LS: Uniform, very fine texture. Blue clay with some silt and little sand.
15-LS	456.4	Non-Coherent	29	12	13.1	124.2	15-LS: Uniform, very fine texture. Silty very fine to fine gray sand. Tr. clay.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT. UNDER NORMAL PRESSURE OF 4 psi.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 14
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: [illegible] DATE: [illegible]

LOG OF SOIL PROFILE
BY RCPCo VISUAL INSPECTION
GROUND SURFACE
ELEVATION = 590.2'
(USC & GS DATUM)

ELEVATION IN FEET

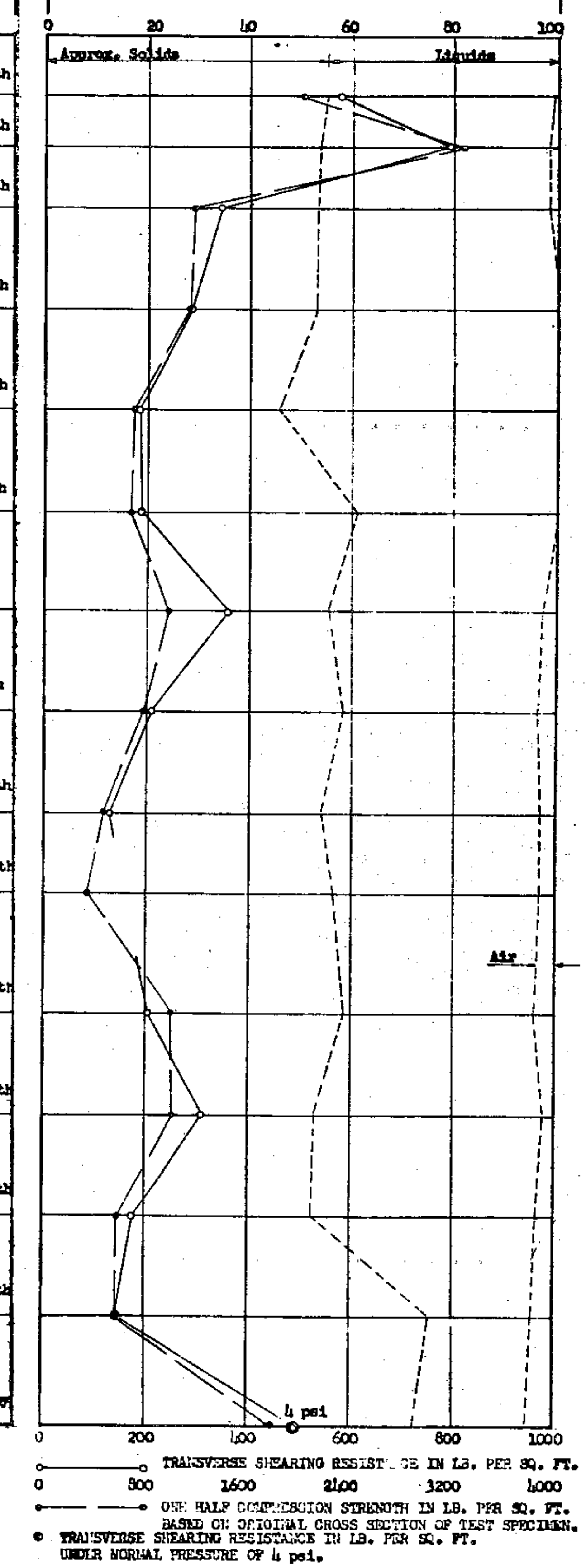
- Med. Vari-colored Clay.
- Hard Vari-Colored Clay, Little Sand & Gravel.
- Medium Yellow Clay, Trace Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Little Sand & Gravel, Few Sand Seams.
- Medium Blue Clay, Trace of Sand & Gravel.
- Hardpan; Sand.
- Hardpan; Compact Fine to Med. Gray Sand Seams, Clayey Sand with Some Gravel.
- Refusal.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-RS	586.7	- -	42	12			
2-LS	584.2	Firm	15	12	29.8	93.0	2-LS: Uniform, very fine texture. Smooth vari-colored clay with little silt.
3-LS	579.2	Stiff	9	12	30.7	90.5	3-LS: Uniform, very fine texture. Smooth yellow clay with little silt.
4-LS	573.2	Plastic	6	12	31.2	89.9	4-LS: Uniform, very fine texture. Smooth yellow clay with little silt.
5-LS	563.2	Plastic	5	13	33.0	89.2	5-LS: Uniform, very fine texture. Smooth blue clay with little silt.
6-LS	553.2	Soft	5	14	43.0	77.4	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	543.2	Soft	4	13	36.4	84.9	7-LS: Uniform, very fine texture. Smooth blue clay with little silt.
8-LS	533.2	Plastic	6	12	23.9	102.7	8-LS: Uniform, very fine texture. Blue clay with little silt and tr. of sand.
9-LS	523.2	Soft to Plastic	7	12	28.5	93.0	9-LS: Uniform, very fine texture. Smooth silty blue clay.
10-LS	513.2	Soft	7	12	24.5	98.0	10-LS: Uniform, very fine texture. Smooth silty blue clay.
	508.2	- -	14	12			
11-LS	505.2	V.Soft	7	12	29.4	91.3	11-LS: Uniform, very fine texture. Smooth silty blue clay.
	495.2	- -	7	12			
12-LS	493.2	Plastic	7	12	26.3	95.5	12-LS: Uniform, very fine texture. Smooth silty blue clay with tr. of sand.
13-LS	483.2	Plastic	9	12	23.4	99.2	13-LS: Uniform, very fine texture. Smooth blue clay with little silt.
14-LS	473.2	Soft	9	12	31.3	89.2	14-LS: Uniform, very fine texture. Smooth blue clay with little silt.
15-LS	463.2	Soft	9	12	30.7	88.6	15-LS: Uniform, very fine texture. Smooth silty blue clay.
16-LS	452.3	Firm	90	12	9.9	127.9	16-LS: Uniform, very fine texture. Clayey fine gray sand. Little silt.
17-RS	446.0	- -	200	2	- -	- -	

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 15
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.K. Housel DATE: 2-3-54
UNIVERSITY OF MICHIGAN PROJECT M173-66

LOG OF SOIL PROFILE

BY ROPO's VISUAL INSPECTION
GROUND SURFACE
ELEVATION = 589.1'
(USC & GS DATUM)

- Med. Vari-colored Clay.
- Med. Hard V.-Colored Clay, Little Sand & Gravel.
- Hard Yellow Clay, Trace Sand & Gravel.
- Med. Yellow Clay, Trace Sand & Gravel.
- Soft Blue Clay, Trace of Sand & Gravel.
- Soft Blue Clay, Little Sand & Gravel.
- Sandy Med. Blue Clay, Little Gravel.
- Med. Blue Clay, Little Sand & Gravel.
- Hardpan; Comp. Clayey F. to C. Grey Sd. & Gr.
- Hardpan; V. Comp. Fine Grey Sd., Little Cl. & Gr. Broken Shale in Bottom of Spoon.
- Boring Stopped.

ELEVATION IN FEET: 580, 570, 560, 550, 540, 530, 520, 510, 500, 490, 480, 470, 460, 450, 440

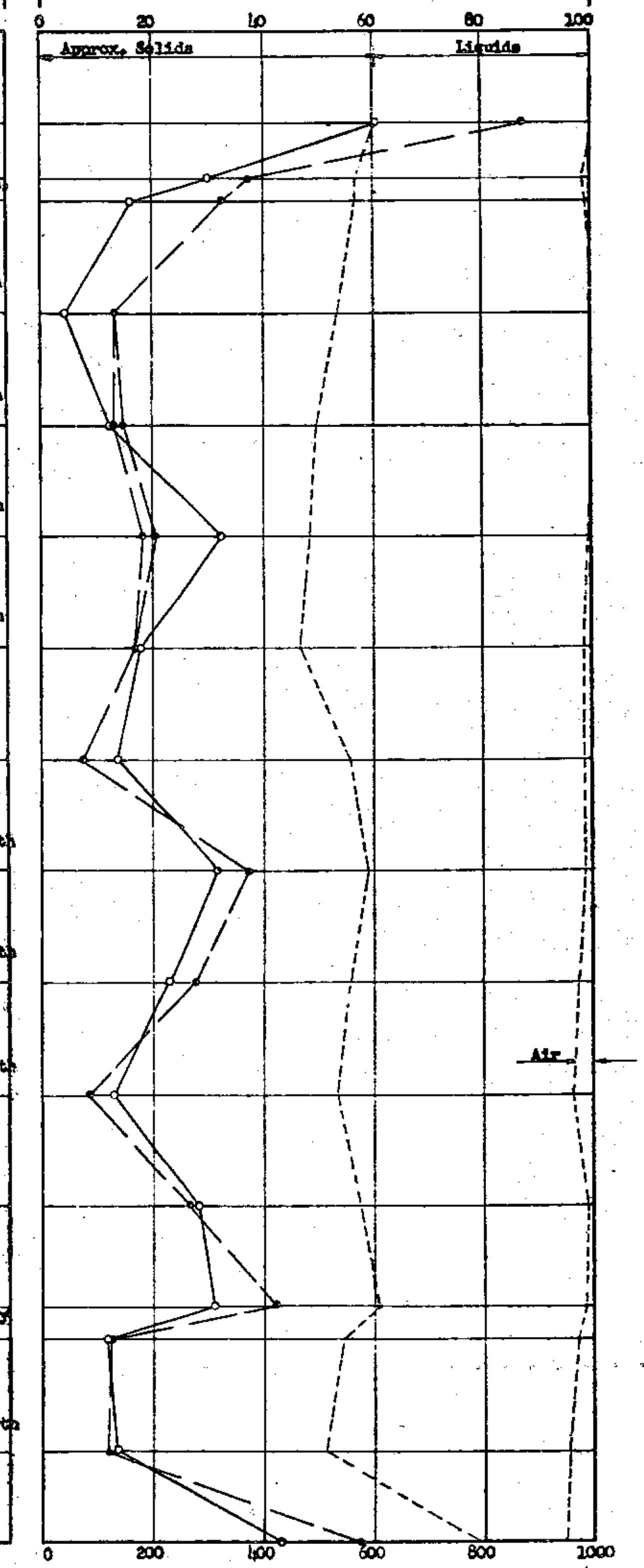
SOIL SAMPLE							LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-HS	585.6	- -	15	12			
2-LS	581.1	Stiff	20	12	24.4	102.3	2-LS: Uniform, very fine texture. Smooth vari-colored clay with little silt.
3-LS	576.1	Plastic to Firm	8	12	26.9	96.7	3-LS: Uniform, very fine texture. Smooth gray clay with little silt.
4-LS	574.1	S. to Pl.	6	13	27.9	95.5	4-LS: Uniform, very fine texture. Smooth silty blue clay.
5-LS	564.1	V. Soft	4	12	32.8	89.9	5-LS: Uniform, very fine texture. Smooth blue clay with little silt.
6-LS	554.1	Soft	3	12	37.8	83.6	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	544.1	Soft to Plastic	3	13	39.9	81.1	7-LS: Uniform, very fine texture. Smooth blue clay with little silt.
8-LS	534.1	Soft	3	12	41.9	78.0	8-LS: Uniform, very fine texture. Smooth blue clay with little silt.
9-LS	524.1	Soft	5	12	28.5	93.6	9-LS: Uniform, very fine texture. Blue clay with little silt and sand.
10-LS	514.1	Plastic	7	12	25.1	99.2	10-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
11-LS	504.1	Plastic	7	12	27.8	93.6	11-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
12-LS	494.1	Soft	7	12	29.7	89.9	12-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
13-LS	484.1	Plastic	7	12	26.9	96.7	13-LS: Uniform, very fine texture. Blue clay with some silt. Little sand.
14-LS	475.1	Plastic	17	12	23.3	101.7	14-LS: Uniform, very fine texture. Blue clay with some silt. Little sand.
15-LS	472.1	Soft	9	12	29.3	91.1	15-LS: Uniform, very fine texture. Silty blue clay with little sand.
16-LS	462.1	Soft	9	12	32.2	86.1	16-LS: Uniform, very fine texture. Smooth silty blue clay with trace sand.
17-LS	454.2	Firm to Stiff	37	12	7.5	132.9	17-LS: Uniform, very fine texture. Sandy, silty blue clay. Trace pebbles.
18-HS	449.6	- -	200	6			
19-HS	444.8	- -	200	4	- -	- -	

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7453-D.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES

PER CENT OF VOLUME OF SOLIDS, LIQUIDS, AND AIR



TRANSVERSE SHEARING RESISTANCE IN LB. PER SQ. FT.

0 800 1600 2400 3200 4000

ONE HALF COMPRESSION STRENGTH IN LB. PER SQ. FT. BASED ON ORIGINAL CROSS SECTION OF TEST SPECIMEN.

ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 16 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN THE DETROIT EDISON COMPANY
APPROVED: W.S. Housel DATE: 12-13-50

UNIVERSITY OF MICHIGAN PROJECT ...

LOG OF SOIL PROFILE

BY ENGR. VISUAL INSPECTION

GROUND SURFACE ELEVATION = 582.2 (USC&GS DATUM)

ELEVATION IN FEET: 580, 570, 560, 550, 540, 530, 520, 510, 500, 490, 480, 470, 460, 450, 440

- Fill; Coal and Stones.
- Fill; Medium Varicolored Clay, Some Cinders.
- Soft Varicolored Clay.
- Soft Gray Clay, Trace of Sand.
- Loose Fine to Very Fine Dark Gray Sand.
- Soft Gray Clay, Trace of Sand.
- Medium Gray Clay, Trace of Sand and Fine Gravel.
- Sandy Medium Hard Gray Clay, Few Sand Seams.
- Medium Gray Clay, Trace of Sand.
- Hardpan; Compact Clayey Fine to Medium Gray Sand, Some Gravel.
- Hardpan; Compact Medium to Fine Gray Sand, Little Clay.
- Hardpan; Very Hard Sandy Gray Clay, Trace of Gravel.
- Boring Stopped.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-25056-D.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA NO.	ELEV	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT LBS PER CU. FT.	REMARKS
1-BS	579.2	--	5	12			
2-BS	576.2	--	5	12			
3-BS	572.2	--	4	12			
4-LS	567.2	Plastic	4	12	30.9	91.1	4-LS: Uniform. Gray clay, some silt, trace of sand.
5-LS	562.2	Soft	2	14	32.6	89.2	5-LS: Uniform. Gray clay, some silt, trace of sand.
6-LS	557.2	Soft	2	14	37.1	83.0	6-LS: Uniform. Gray clay, some silt, trace of sand.
7-LS	552.2	Soft	2	16	40.3	80.5	7-LS: Uniform. Gray clay, some silt, trace of sand.
8-LS	547.2	Soft	2	15	45.0	76.1	8-LS: Uniform. Gray clay, some silt, trace of sand.
9-LS	543.2	Plastic	8	12	25.4	95.5	9-LS: Uniform. Clayey gray silt, little sand.
10-LS	538.2	Very Soft	5	12	27.6	93.9	10-LS: Non-uniform. Varies from silty gray clay, trace of sand to clayey gray silt, little sand.
11-LS	533.2	Soft	6	12	23.1	99.2	11-LS: Uniform. Clayey gray silt, little sand.
12-LS	531.2	Plastic	4	12	22.7	101.1	See Note A.
13-LS	527.2	Plastic	4	13	23.3	101.7	13-LS: Uniform. Silty gray clay, some sand, trace of gravel.
14-BS	522.2	--	4	12			
15-LS	517.2	Plastic	5	14	24.9	99.8	15-LS: Uniform. Silty grey clay, some sand, trace of gravel.
	512.2	--	4	12			
16-LS	507.2	Plastic	8	13	25.9	100.5	16-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
17-LS	502.2	Plastic	7	13	28.0	93.0	17-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
	497.2	--	7	12			
18-LS	492.2	Soft	7	12	27.3	94.3	18-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
19-LS	487.2	Soft to Plastic	7	12	26.4	95.5	19-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
20-LS	482.2	Soft to Plastic	8	12	25.7	96.7	20-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
21-LS	477.2	Soft to Plastic	17	12	11.3	123.6	21-LS: Non-uniform. Varies from silty gray clay to clayey silty gray sand.
22-LS	473.2	Very Soft	8	12	33.3	86.1	22-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
23-LS	468.2	Soft	7	12	38.0	82.4	23-LS: Uniform. Gray clay, some silt, trace of sand.
24-LS	463.2	Soft	6	12	45.0	70.5	24-LS: Uniform. Gray clay, trace of silt and sand.
	458.2	--	7	12			
25-BS	454.1	--	72	12			
26-BS	451.7	--	36	12			
27-BS	449.9	--	106	12			

Indicates failure to recover Liner Sample

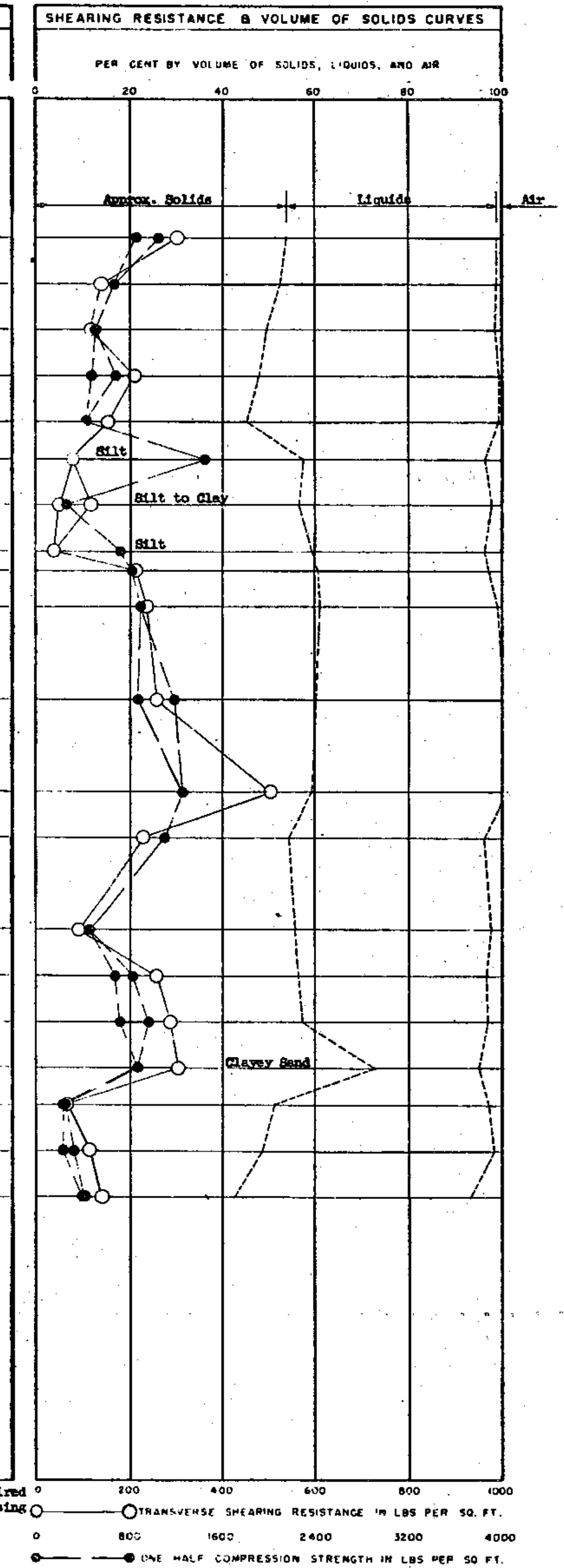
NOTE: Permanent Ground Water Level assumed to be the level of the St. Clair River adjacent to the site.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

Note A

12-LS: Uniform. Silty grey clay, some sand, trace of gravel.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN

SUBSOIL ANALYSIS OF BORING NO 20
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN

APPROVED: [illegible] DATE: 9-2-57

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01994

LOG OF SOIL PROFILE

BY BCPCo. VISUAL INSPECTION

GROUND SURFACE ELEVATION = 581.2 (DECAGS DATUM)

ELEVATION IN FEET

- Fill; Cinders.
- Fill; Clay and Cinders.
- Soft Silty Yellow Clay.
- Soft Varicolored Clay.
- Soft Gray Clay, Trace of Sand.
- Firm Fine to Very Fine Dark Gray Sand.
- Medium Gray Clay, Some Sand and Gravel.
- Soft Gray Clay, Trace of Sand and Gravel.
- Medium Gray Clay, Trace of Sand and Gravel.
- Firm Fine Gray Sand, Some Clay.
- Hardpan; Very Compact Clayey Very Fine to Medium Gray Sand.
- Boring Stopped.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-25056-D.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA. NO.	ELEV.	LAB CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT. LBS. PER CU. FT.	REMARKS
1-BS	579.2	--	5	12			
2-BS	577.2	--	5	12			
3-LS	575.2	Soft	2	12	38.2	83.0	3-LS: Uniform. Yellow clay, some silt, trace of sand.
4-LS	571.2	Soft	2	15	39.3	81.4	4-LS: Uniform. Yellow clay, some silt, trace of sand.
5-LS	566.2	Soft	2	12	37.9	81.1	See Note A.
6-LS	561.2	Plastic	3	14	30.7	92.4	6-LS: Uniform. Grey clay, some silt, trace of sand.
7-LS	556.2	Soft	3	14	32.6	88.6	7-LS: Uniform. Gray clay, some silt, trace of sand.
8-LS	551.2	Soft	2	18	40.4	81.1	8-LS: Uniform. Gray clay, some silt, trace of sand.
9-LS	546.2	Soft	2	16	42.8	76.8	9-LS: Uniform. Gray clay, some silt, trace of sand.
10-LS	542.1	Firm	18	12	20.2	104.8	10-LS: Uniform. Clayey gray silt, little sand.
11-LS	537.2	Plastic	11	12	20.8	105.5	11-LS: Uniform. Clayey gray silt, little sand.
12-LS	532.2	Plastic	7	13	21.4	103.6	12-LS: Uniform. Clayey gray silt, little sand.
13-LS	527.2	Plastic	5	14	23.2	101.7	13-LS: Uniform. Silty gray clay, some sand, trace of gravel.
14-LS	522.2	Plastic	4	12	24.0	99.2	14-LS: Uniform. Silty gray clay, some sand, trace of gravel.
15-LS	517.2	Plastic	5	12	18.0	109.2	15-LS: Uniform. Silty gray clay, some sand, trace of gravel.
16-LS	512.2	Plastic	5	12	33.8	85.8	16-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
17-LS	507.2	Plastic	5	13	27.2	94.8	17-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
18-LS	502.2	Plastic	4	12	26.7	99.8	18-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
19-LS	497.2	Plastic	5	12	26.1	96.1	19-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
20-LS	492.2	Plastic	6	12	26.0	92.4	20-LS: Uniform. Grey clay, some silt, trace of sand and gravel.
21-LS	487.2	Plastic	8	12	27.2	94.2	21-LS: Uniform. Grey clay, some silt, trace of sand and gravel.
22-BS	482.2	--	7	12			
23-LS	476.2	Soft	7	12	26.5	95.2	23-LS: Uniform. Grey clay, some silt, trace of sand and gravel.
24-LS	471.2	Soft to Plastic	7	12	28.7	91.4	24-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
25-LS	466.2	Soft	7	12	31.8	88.0	25-LS: Uniform. Gray clay, some silt, trace of sand and gravel.
	461.2	--	7	12			
	457.2	--	12	12			
26-BS	455.8	--	100	8			
27-BS	451.9	--	100	4			

⊠ Indicates failure to recover Liner Sample

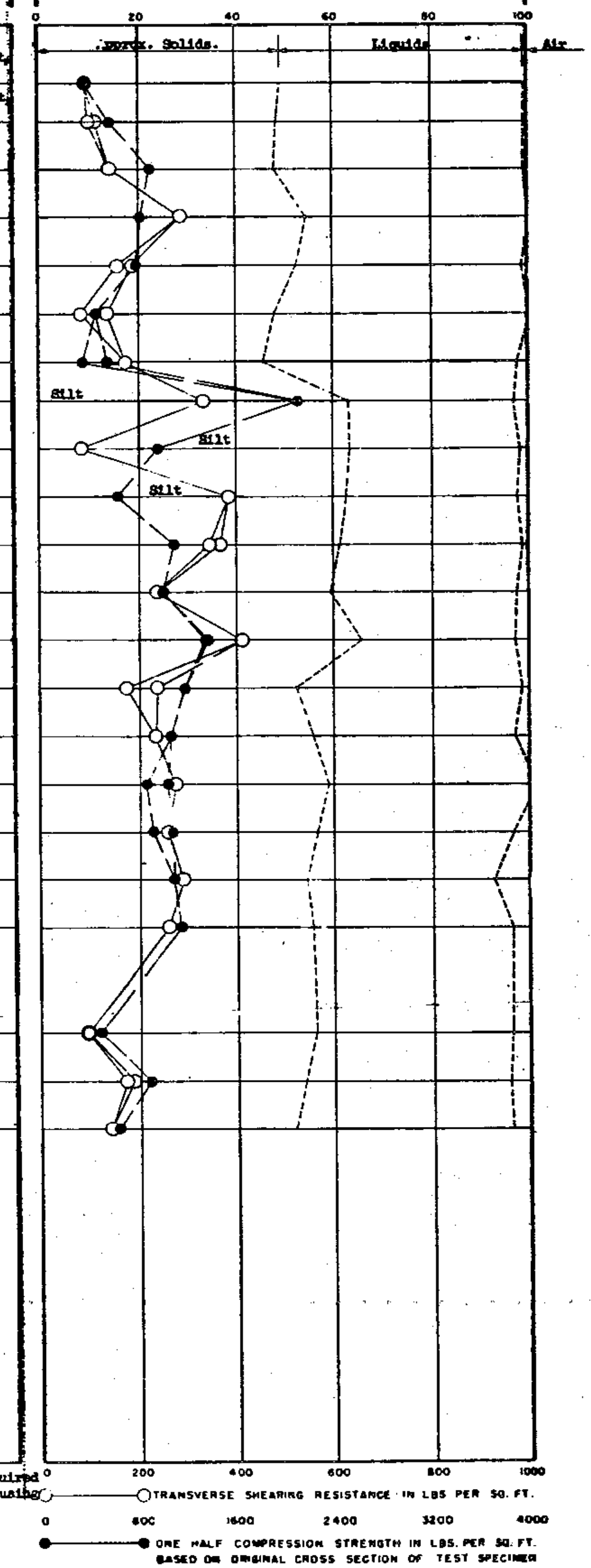
NOTE: Permanent Ground Water Level assumed to be the level of the St. Clair River adjacent to the site.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

Note A

5-LS: Uniform. Mottled yellow and gray clay, some silt, trace of sand with pocket of clayey gray silt, trace of organic matter.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 21
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN

APPROVED: [signature] DATE: 11-2-59

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 588.60 Ft. (USING USC & GS DATUM)

- Stiff Sandy Varicolored Clay.
- Medium Sandy Brown Clay
- Soft Gray Clay, Some Sand, Trace of Gravel
- Medium Gray Clay, Some Sand, Trace of Gravel.
- Very Compact Medium Clayey Gray Sand. Boring Stopped.

Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc. Their Job No. RCE-11914-D. Date of Boring: 12-20-66.

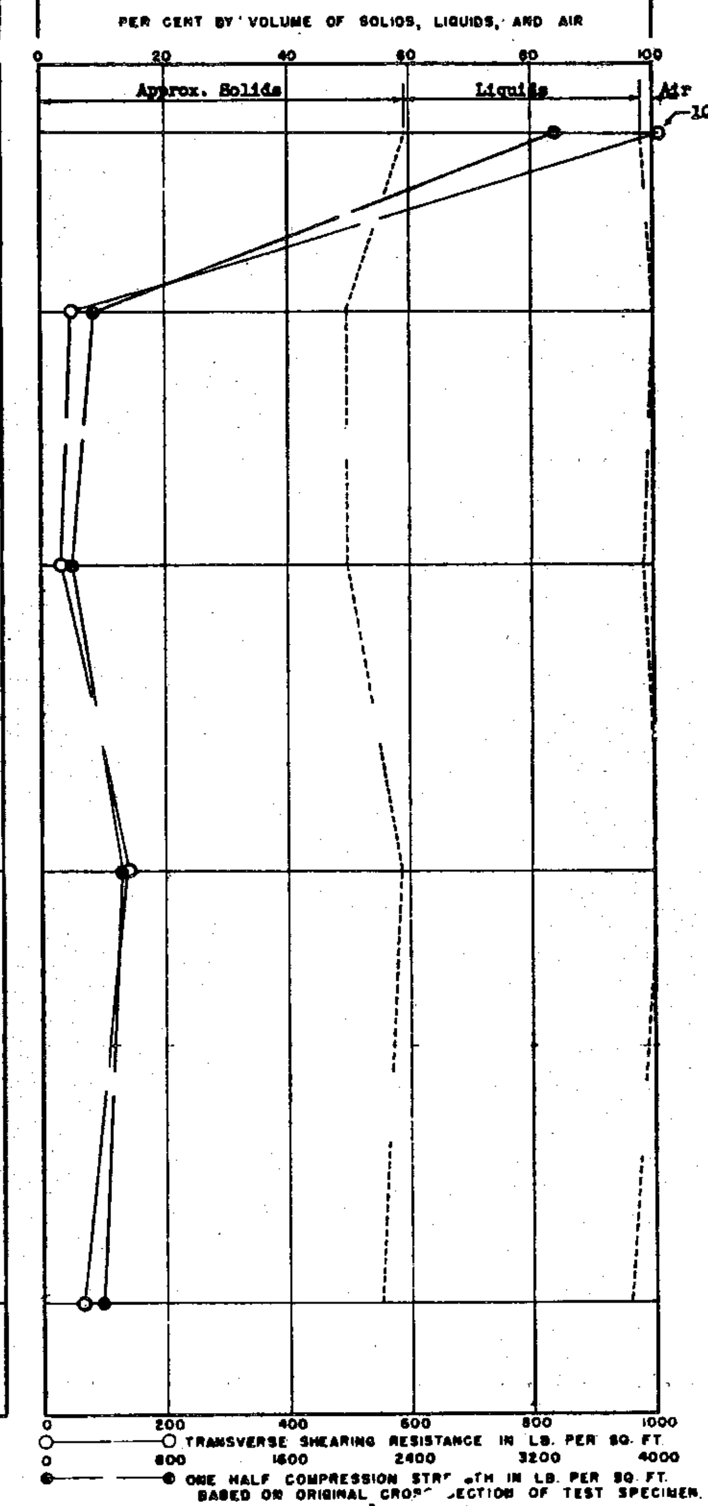
SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA. NO.	ELEV.	LAB CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
1-BS	586.1	--	16	12			
2-LS	583.1	Stiff	15	12	24.2	99.2	2-LS: Uniform. Silty mottled brown-gray clay.
3-BS	578.6	--	10	12			
4-BS	573.1	--	5	12			
5-LS	568.6	Very Soft	4	12	37.4	84.2	5-LS: Uniform. Silty gray clay, trace of very fine sand.
6-BS	563.6	--	2	12			
7-BS	558.1	--	2	11			
8-BS	553.1	--	2	11			
9-LS	548.1	Very Soft	3	13	35.0	86.7	9-LS: Uniform. Silty gray clay.
10-BS	543.1	--	2	12			
11-BS	538.1	--	2	12			
12-BS	533.1	--	3	12			
13-BS	528.6	--	6	12			
14-LS	523.1	Soft	9	12	26.8	98.6	14-LS: Uniform. Silty gray clay, trace of sand and gravel.
15-BS	518.6	--	10	12			
16-BS	513.6	--	11	12			
17-BS	508.6	--	12	12			
18-BS	503.6	--	13	12			
19-BS	498.6	--	14	12			
20-BS	493.1	--	11	12			
21-LS	488.1	Very Soft	9	12	27.3	93.0	21-LS: Uniform. Silty gray clay, trace of sand and gravel.
22-BS	483.6	--	10	12			
23-BS	478.6	--	10	12			
24-BS	473.6	--	10	12			
25-BS	468.6	--	10	12			
26-BS	463.6	--	10	12			
27-BS	458.6	--	8	12			
28-BS	453.4	--	100	5			

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

Failure to recover Liner Sample.
WL: Water Level 16 hours after completion.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 29
CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN

APPROVED: W.J. Hansen DATE: 6-14-67

PROJECT: 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 572 Ft. (USING USC & GS DATUM)

ELEVATION IN FEET

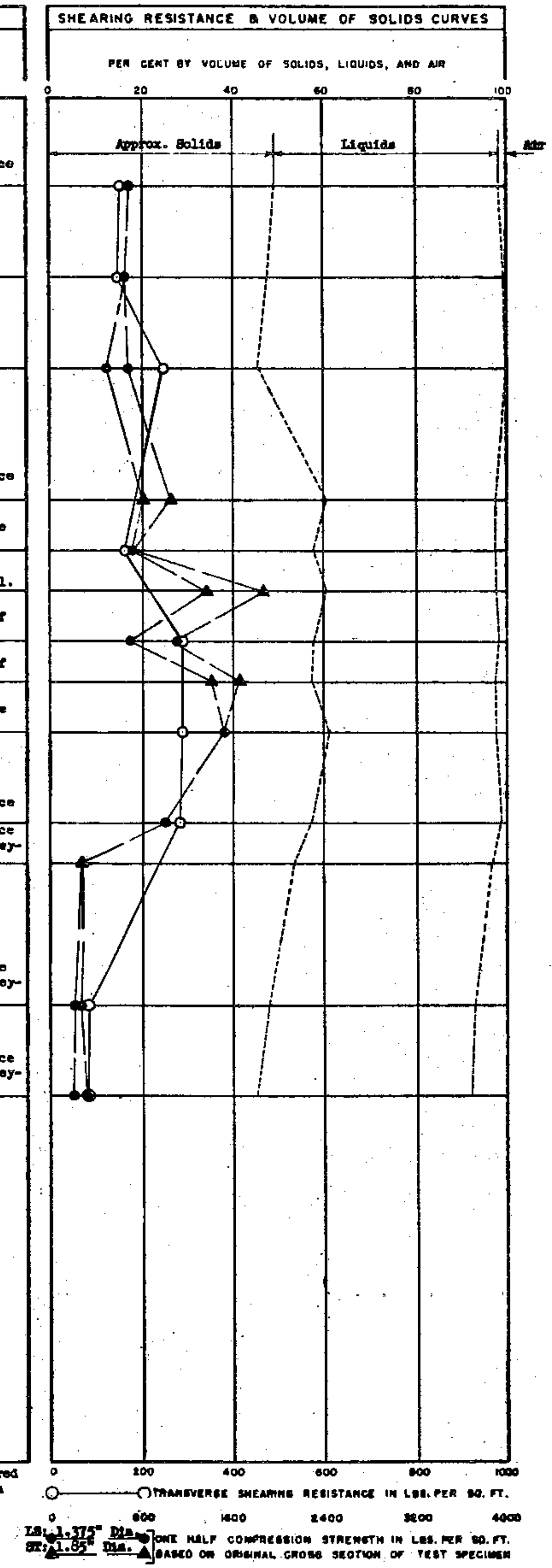
Elevation	Description
570 – approx. 532	Soft Gray Clay, Trace of Fine Sand.
approx. 532 – approx. 482	Medium Gray Clay with Fine Sand and Traces of Gravel.
approx. 482 – approx. 457	Medium Gray Clay with Fine Sand.
approx. 457 – approx. 453.7	Very Compact Clayey, Fine to Coarse Gray Sand and Gravel.
approx. 453.7	Boring Stopped.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LBS. PER CU. FT.	REMARKS
1-SS	567.0	--	3	12			
2-LS	562.0	Soft	2	12	36.7	84.2	2-LS: Uniform. Silty gray clay, trace of gravel.
Lost SS	557.0	--	2	12			
3-LS	552.0	Soft	2	12	39.5	81.7	3-LS: Uniform. Silty gray clay.
4-SS	547.0	--	2	12			
5-LS	542.0	Soft	3	12	44.3	76.1	5-LS: Uniform. Silty gray clay.
6-SS	537.0	--	3	12			
Lost LS	532.0	--	3	12			
7-ST	527.0	Soft	Pushed		22.6	102.1	7-ST: Uniform. Silty gray clay, trace of gravel. Few sand pockets.
8-LS	522.0	Soft	8	12	25.7	97.3	8-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
9-ST	517.0	Plastic	Pushed		22.8	102.3	9-ST: Uniform. Silty laminated gray clay, trace of sand and gravel.
10-LS	512.0	Soft to Plastic	9	12	26.2	97.3	10-LS: Uniform. Silty laminated gray clay, some fine sand, trace of gravel.
11-ST	507.0	Plastic	Pushed		25.9	96.7	11-ST: Uniform. Silty laminated gray clay, some fine sand, trace of gravel.
12-LS	502.0	Plastic	13	12	21.9	103.6	12-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
Lost ST	497.0	--	Pushed				
13-LS	492.0	Plastic	11	12	26.8	96.7	13-LS: Uniform. Silty gray clay, trace of fine sand and gravel.
14-ST	487.0	Very Soft	Pushed		29.7	91.1	14-ST: Uniform. Silty gray clay, trace of fine sand and gravel. Honey-combed.
Lost LS	482.0	--	10	12			
Lost ST	477.0	--	Pushed				
Lost ST	474.0	--	Pushed				
15-LS	472.0	V.Soft	13	12	34.5	81.4	15-LS: Uniform Silty gray clay, trace of fine sand and gravel. Honey-combed.
16-BS	467.0	--	14	12			
17-LS	462.0	Very Soft	14	12	38.2	77.1	17-LS: Uniform. Silty gray clay, trace of fine sand and gravel. Honey-combed.
Lost LS	457.0	--	14	12			
18-SS	453.7	--	100	10			

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. RCB-11914-D.
Date of Boring: 2-11-67

Failure to recover Liner Sample.
LS: Undisturbed Liner Sample 1.375" diameter.
BS: Disturbed Sample.
ST: Undisturbed Shelby Tube Sample 1.85" diameter.
SS: Standard Spoon Sample.
Water Level Not Given.

OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 29A
CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
DETROIT EDISON COMPANY BELLE RIVER, MICHIGAN

APPROVED: W.H. Housel DATE: 6-14-67

OFFICE OF RESEARCH ADMINISTRATION PROJECT 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 588.80 Ft.
(USING USC & GS DATUM)

ELEVATION IN FEET

Elevation	Soil Profile
	Fill; Soft Varicolored Clay, Limestone.
	Medium Varicolored Sandy Clay.
580	Stiff Varicolored Clay, Trace of Gravel.
	Medium Varicolored Clay.
570	
560	
	Soft Gray Clay.
550	
540	
	Soft Gray Clay, With Seams of Fine Silty Gray Sand.
530	Firm Coarse Gray Sand, Some Gravel.
520	
510	
	Medium Sandy Gray Clay, with Gravel.
490	
480	
470	
460	Firm Medium Gray Sand, Some Gravel, Clay Binder.
	Refusal.
450	

Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. KCB-11914-F
Date of Boring: 1-13-67

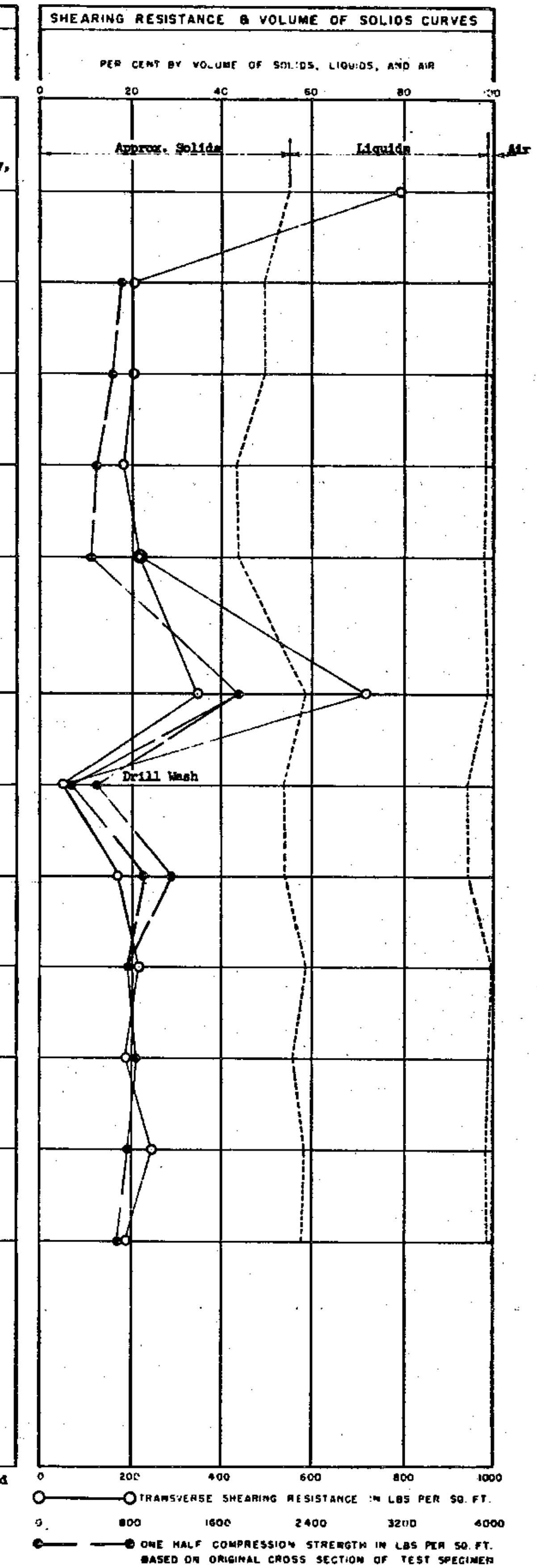
SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA NO	ELEV	LAB CONSISTENCY	PENETRATION NO OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT LBS PER CU FT	REMARKS
1-BS	586.3	--	4	12			
2-BS	583.8	--	12	12			
3-LS	578.8	Firm to Stiff	16	12	28.8	94.8	3-LS: Uniform. Silty, brown-gray clay, trace of sand.
4-BS	573.8	--	7	12			
5-LS	568.8	Soft	4	12	36.6	84.9	5-LS: Uniform. Silty gray clay, trace of sand.
6-BS	563.8	--	3	12			
7-LS	558.8	Soft	4	12	35.5	85.5	7-LS: Uniform. Silty gray clay, trace of sand.
8-BS	553.8	--	3	12			
9-LS	548.8	Soft	3	12	46.2	74.3	9-LS: Uniform. Silty gray clay.
10-BS	543.8	--	3	12			
11-LS	538.8	Soft	3	12	45.0	75.2	11-LS: Uniform. Silty gray clay.
12-BS	533.8	--	4	12			
13-BS	526.8	--	23	12			
14-LS	523.8	Plastic to Firm	12	12	25.1	99.6	14-LS: Uniform. Silty laminated gray clay, some fine sand, trace of gravel.
15-BS	518.8	--	14	12			
16-LS	513.8	Soft	14	12	27.7	91.2	16-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
17-BS	508.8	--	14	12			
18-LS	503.8	Soft	14	12	27.6	93.0	18-LS: Uniform. Silty laminated gray clay, some fine sand, trace of gravel
19-BS	498.8	--	13	12			
20-LS	493.8	Soft	11	12	25.8	99.2	20-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
21-BS	488.8	--	10	12			
22-LS	483.8	Soft	9	12	28.2	94.8	22-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
23-BS	478.8	--	10	12			
24-LS	473.8	Soft	11	12	25.4	98.6	24-LS: Uniform. Silty laminated gray clay, some fine sand, trace of gravel.
25-BS	468.8	--	10	12			
26-LS	463.8	Soft	10	12	26.2	98.0	27-LS: Uniform. Silty gray clay, some fine sand, trace of gravel. Honeycombed.
27-BS	458.8	--	11	12			
28-BS	453.8	--	10	12			
	452.6	--	100	1			

Water Level not given.

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



OFFICE OF RESEARCH ADMINISTRATION SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 30 CAR DUMPER HOUSE - ST. CLAIR POWER PLANT THE DETROIT EDISON COMPANY BELLE RIVER, MICHIGAN
APPROVED: W.G. Housel DATE: 6-14-67

OFFICE OF RESEARCH ADMINISTRATION 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 588.80 Ft. (USING USC & GS DATUM)

Elevation in feet	Soil profile
580	Stiff Sandy Varicolored Clay, Some Gravel.
	Medium Gray Clay, Trace of Gravel.
570	W.L.
550	Soft Gray Clay, Trace of Gravel.
	Medium Gray Clay, Some Sand, Trace of Gravel.
	Medium Sandy Gray Clay, Some Rouge Streaks.
	Very Compact Medium Gray Sand.
450	Soft Gray Shale.
	Hard Gray Shale.
	Boring Stopped.

Elevation scale (ELEVATION IN FEET): 580, 570, 560, 550, 540, 530, 520, 510, 500, 490, 480, 470, 460, 450, 440

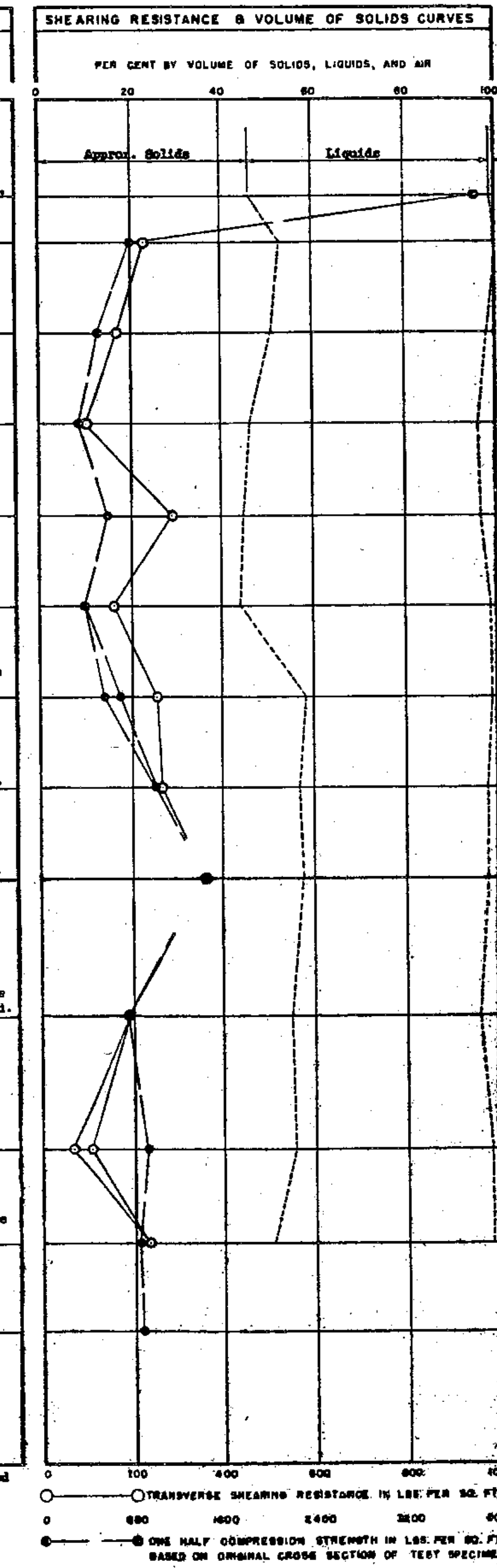
SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT. LBS. PER CU. FT.	REMARKS
1-BS	586.3	--	21	12			
2-BS	583.8	--	22	12			
3-LS	578.3	Stiff	17	12	41.7	79.2	3-LS: Uniform. Silty varicolored clay.
4-LS	573.3	Soft	5	12	32.5	91.1	4-LS: Uniform. Silty gray clay.
5-BS	568.8	--	3	11			
6-LS	563.3	Soft	3	12	33.3	88.0	6-LS: Uniform. Silty grey clay.
7-BS	558.8	--	3	12			
8-LS	553.3	Very Soft	4	12	38.5	81.1	8-LS: Uniform. Silty gray clay.
9-BS	548.3	--	4	12			
10-LS	543.3	Soft	4	12	42.1	77.4	10-LS: Uniform. Silty gray clay.
11-BS	538.8	--	4	12			
12-LS	533.3	Soft	4	12	45.1	76.1	12-LS: Uniform. Silty gray clay.
13-BS	528.8	--	4	12			
14-LS	523.3	Soft	6	12	25.9	98.6	14-LS: Uniform. Silty gray clay, trace of sand and gravel.
15-BS	518.8	--	9	12			
16-LS	513.3	Plastic	10	12	26.7	96.1	16-LS: Uniform. Silty laminated gray clay, trace of sand and gravel.
17-BS	508.8	--	10	12			
18-LS	503.3	--	11	12	26.6	97.3	18-LS: Uniform. Silty laminated gray clay, trace of sand and gravel.
19-BS	498.8	--	10	12			
	493.3	--	11	12			
20-LS	488.3	Soft to Plastic	9	12	27.7	93.0	20-LS: Uniform. Silty gray clay, trace of sand and gravel. Honeycombed.
	478.8	--	16	12			
21-LS	473.8	Soft	9	12	28.6	94.0	21-LS: Uniform. Silty gray clay, some sand, trace of gravel.
22-BS	468.8	--	14	12			
23-LS	463.3	Soft	8	12	34.7	86.1	23-LS: Uniform. Silty gray clay, trace of sand. Honeycombed.
24-BS	458.8	--	9	12			
25-LS	453.8	Soft	12	12	17.4	--	25-LS: Non-uniform. Silty sandy gray clay. Honeycombed.
26-BS	452.8	--	100	3			
27-BS	448.2	--	200	3			
	444.3	--	200	1			

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. RCB-11914-D. Date of Boring: December 1966 to January 1967

WL: Water Level 24 hours after completion.



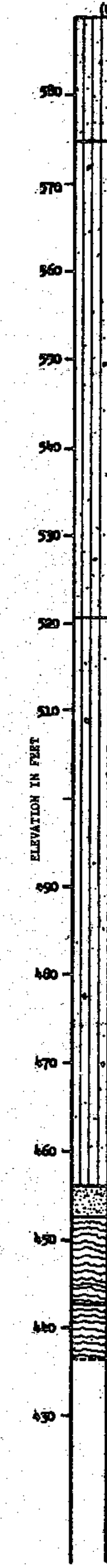
OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 31
CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY BELLE RIVER, MICHIGAN

APPROVED: W.A. Hansel DATE: 6-14-67

OFFICE OF RESEARCH ADMINISTRATION PROJECT 01994

LOG OF SOIL PROFILE
BY R.C.P. DIVISION
GROUND SURFACE ELEVATION= 588.70 Ft. (USING USC & GS DATUM)



Medium Sandy Varicolored Clay.

Soft Gray Clay, Some Sand, Trace of Gravel.

Medium Sandy Gray Clay. Trace of Gravel.

Very Compact Medium Gray Sand.

Soft Gray Shale.

Hard Gray Shale.

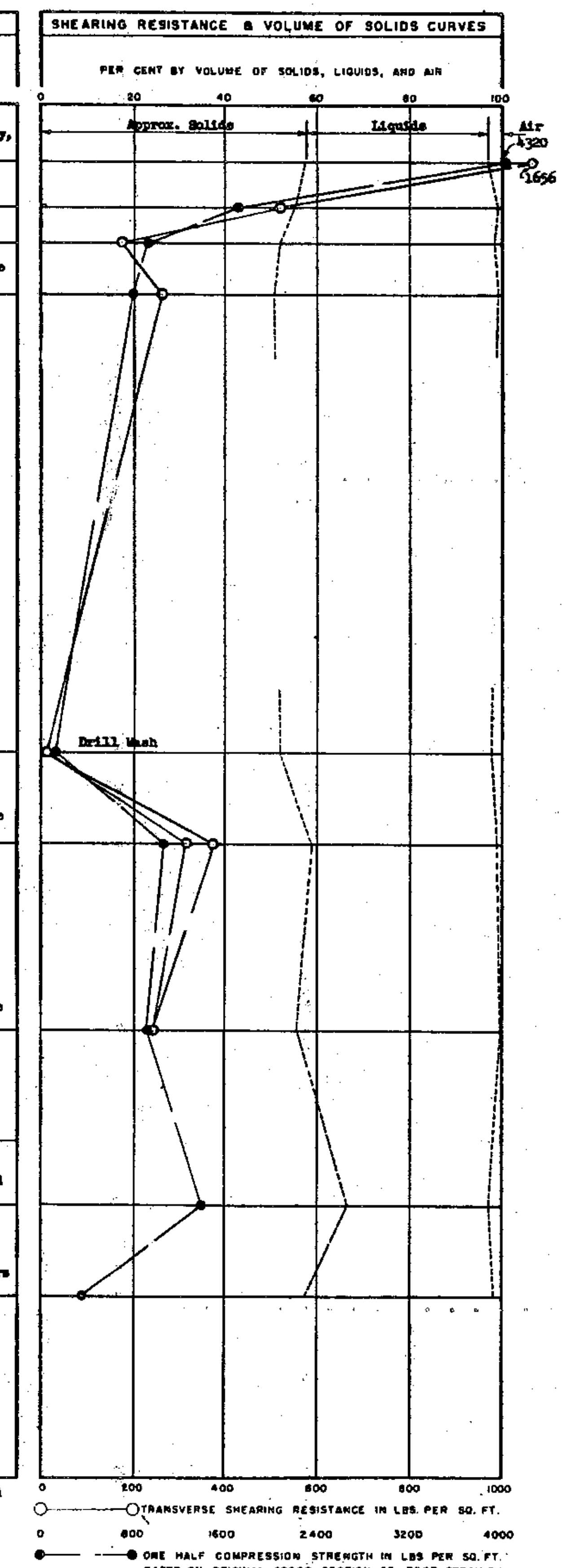
Boring Stopped.

SOIL SAMPLE							LABORATORY VISUAL INSPECTION
		LAB.	PENETRATION		% H_2O	DRY WT	
SA. NO.	ELEV.	CONSISTENCY	NO. OF BLOWS	DRIVE IN INCHES	BY DRY WT.	LBS. PER CU. FT.	REMARKS
1-BS	586.2	--	11	12			
2-LS	582.7	Hard	20	12	24.7	99.2	2-LS: Uniform. Silty varicolored clay, trace of sand.
3-LS	577.7	Plastic	11	12	29.0	94.3	3-LS: Uniform. Silty brown-gray clay.
4-LS	573.7	Soft	5	12	32.5	89.2	4-LS: Uniform. Silty gray clay.
5-LS	568.2	Soft	3	12	35.1	86.1	5-LS: Uniform. Silty gray clay, trace of very fine sand.
6-BS	563.7	--	3	12			
7-BS	558.7	--	3	12			
8-BS	553.7	--	3	11			
9-BS	548.7	--	3	12			
10-BS	543.7	--	3	12			
11-BS	538.7	--	3	11			
12-BS	533.7	--	3	12			
13-BS	528.7	--	4	12			
14-BS	523.7	--	5	12			
15-LS	518.2	Very Soft	6	12	32.6	88.0	15-LS: Uniform. Silty gray clay, some fine sand, trace of gravel.
16-BS	513.7	--	10	12			
17-LS	508.2	Plastic	15	12	24.8	100.2	17-LS: Uniform. Silty gray clay, trace of fine sand and gravel.
18-LS	504.7	--	12	11			
	498.7	--	8	12			
	495.7	--	10	12			
	492.7	--	10	12			
19-LS	487.7	Plastic	12	12	29.1	94.2	19-LS: Uniform. Silty gray clay, trace of fine sand and gravel.
	483.7	--	22	12			
	481.7	--	16	12			
	478.7	--	11	12			
20-LS	475.7	--	14	12	--	--	20-LS: Not Received.
21-LS	468.7	Plastic	16	12	17.0	112.3	21-LS: Uniform. Silty gray clay, some fine sand and gravel. Fine sand pockets.
22-BS	463.7	--	8	12			
23-LS	458.7	Very Soft	12	12	26.1	97.3	23-LS: Uniform. Silty gray clay, layers or lenses of silt.
24-BS	454.0	--	100	9			
25-BS	448.7	--	300	5			
26-BS	444.0	--	200	2			
	439.4	--	200	1/4			

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

WL: Water Level 96 hours after completion.

Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. RCB-11914-D. Date of Boring: January 1967



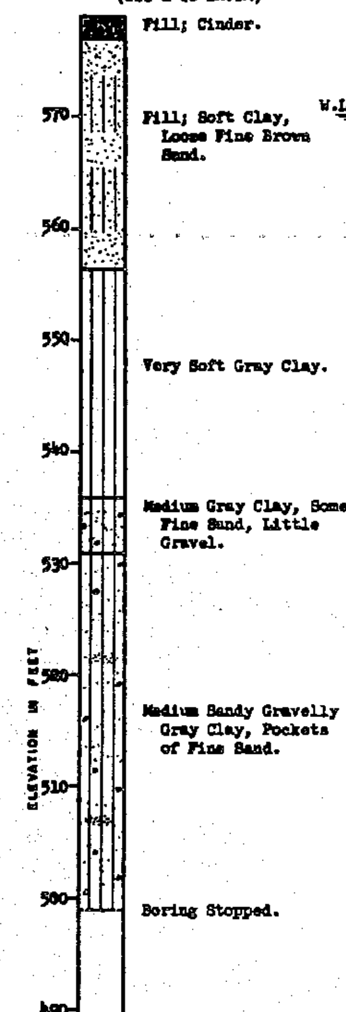
OFFICE OF RESEARCH ADMINISTRATION SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 32
CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY BELLE RIVER, MICHIGAN
APPROVED: W.S. Housel DATE: 6-14-67

OFFICE OF RESEARCH ADMINISTRATION PROJECT 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 579.0 Ft. (USC & GS DATUM)

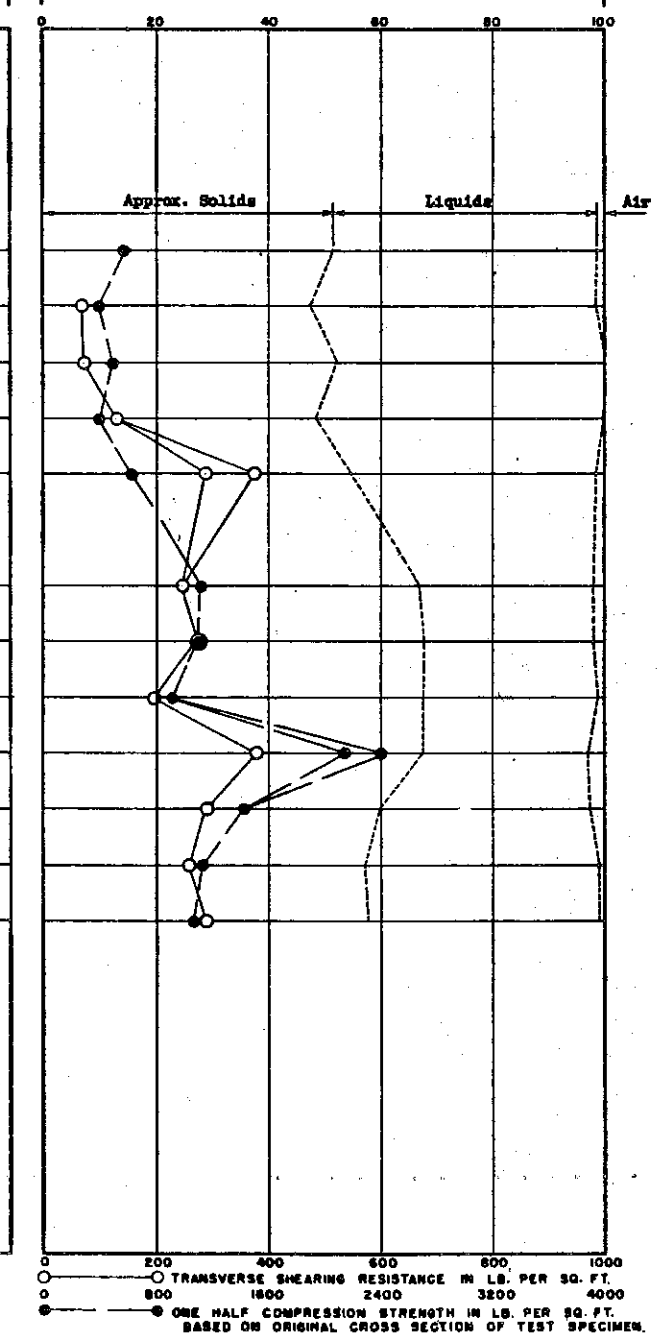


- Fill; Cinder.
- Fill; Soft Clay, Loose Fine Brown Sand.
- Very Soft Gray Clay.
- Medium Gray Clay, Some Fine Sand, Little Gravel.
- Medium Sandy Gravelly Gray Clay, Pockets of Fine Sand.
- Boring Stopped.

SOIL SAMPLE — LABORATORY VISUAL INSPECTION

SA. NO	ELEV	LAB. CONSISTENCY	PENETRATION: NO. OF BLOWS	PENETRATION: DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT LB PER CU. FT	REMARKS
1-BS	574.0	--	1	12			
2-BS	569.0	--	2	12			
3-BS	564.0	--	4	12			
4-LS	559.5	Soft	2	12	33.9	[illegible].7	4-LS: Uniform. Silty mottled tan clay, trace of fine sand, gravel and organic matter. Laminated.
5-LS	554.5	V.Soft	1	12	40.1	[illegible].6	5-LS: Uniform. Silty gray clay.
6-LS	549.5	V.Soft	2	12	34.3	[illegible].0	6-LS: Uniform. Silty gray clay.
7-LS	544.5	V.Soft	2	12	39.4	[illegible].7	7-LS: Uniform. Silty gray clay.
8-LS	539.5	Soft to Plastic	3	12	29.6	[illegible].4	8-LS: Uniform. Silty gray clay, silt pocket, trace of very fine sand.
	534.0	--	5	12			
9-LS	529.5	Soft to Plastic	8	12	17.2	11[illegible].9	9-LS: Uniform. Silty gray clay, some sand, trace of gravel.
10-LS	524.5	Soft to Plastic	8	12	16.5	114.2	10-LS: Uniform. Silty gray clay, some sand, trace of gravel.
11-LS	519.5	Soft	8	12	17.5	111.7	11-LS: Uniform. Silty gray clay, some sand, trace of gravel.
12-LS	514.5	Plastic to Firm	8	12	16.1	113.9	12-LS: Uniform. Silty gray clay, some sand, trace of gravel.
13-LS	509.5	Plastic	11	12	23.2	101.1	13-LS: Uniform. Silty gray clay, some very fine sand, trace of gravel. Laminated.
14-LS	504.5	Plastic	10	12	27.4	96.1	14-LS: Uniform. Silty gray clay, some very fine sand, trace of gravel. Laminated.
15-LS	499.5	Plastic	10	12	26.6	97.3	15-LS: Uniform. Silty gray clay, some very fine sand, trace of gravel. Laminated.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

W.L. Water Level at Completion.

Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc.
Their Job No. RCB-12371-D
Date of Boring: April 12, 1967

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 33
ST. CLAIR POWER PLANT
THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN

APPROVED: W.S. Housel . DATE: 6-14-67

PROJECT NO. 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 581.0 Ft. (USC & GS DATUM)

ELEVATION IN FEET

Elevation	Description
580	Fill; Cinder.
570	Fill; Clay, Sandy Gravel, Concrete. W.L.
550	Very Soft Gray Clay.
535	Soft Gray Clay, Trace of Fine Sand and Little Gravel.
527	Stiff Sandy Gravelly Gray Clay.
512	Medium Gray Clay, Some Fine Sand and Small Gravel.
500	Boring Stopped.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

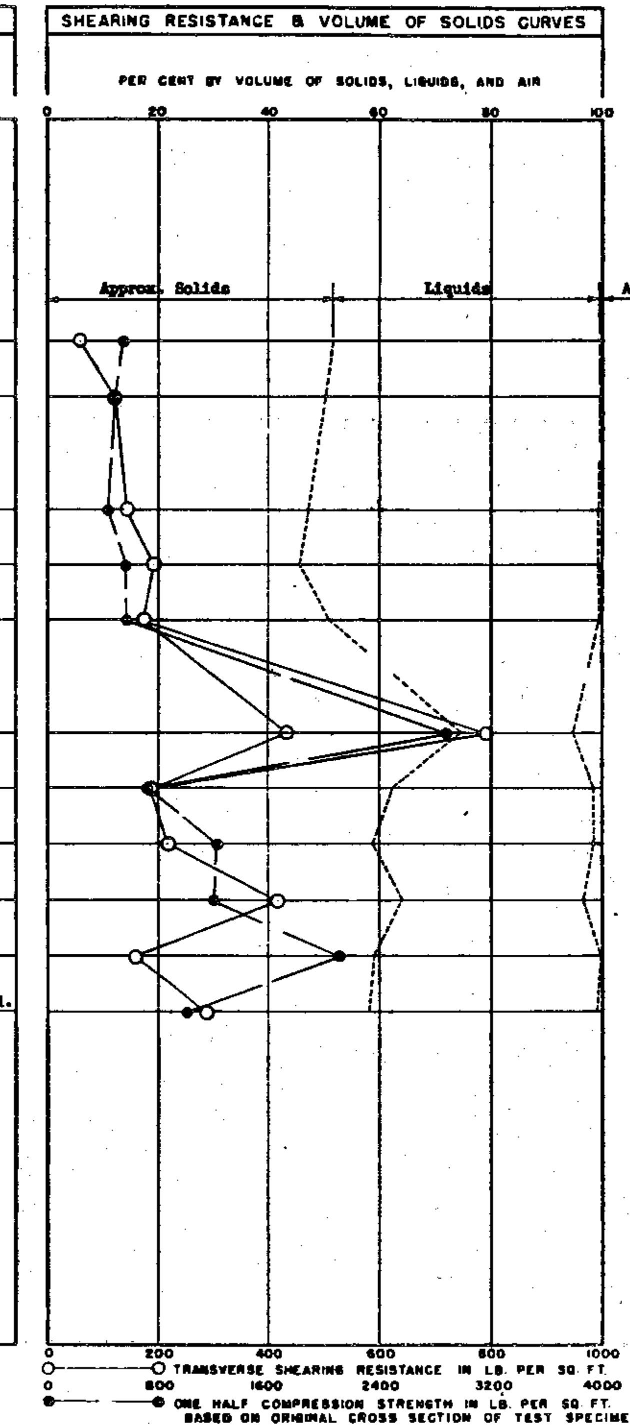
SA NO	ELEV	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT	DRY WT. LB PER CU FT	REMARKS
1-BS	576.0	--	4	12			
2-BS	571.0	--	8	12			
3-BS	566.0	--	5	12			
4-LS	561.5	V.Soft	3	12	34.7	87.4	4-LS: Uniform. Silty gray clay.
5-LS	556.5	V.Soft	2	12	36.3	84.9	5-LS: Uniform. Silty gray clay.
	551.0	--	2	12			
6-LS	546.5	Soft	2	12	41.3	79.2	6-LS: Uniform. Silty gray clay.
7-LS	541.5	Soft	2	12	43.8	76.8	7-LS: Uniform. Silty gray clay.
8-LS	536.5	Soft	4	12	35.6	85.5	8-LS: Uniform. Silty gray clay, trace of very fine sand.
	531.0		4	12			
9-LS	526.5	Firm	23	12	9.9	126.0	9-LS: Uniform. Clayey gravelly gray sand to sandy dark gray clay, trace of organic matter.
10-LS	521.5	Soft	7	12	21.6	104.8	10-LS: Uniform. Silty gray clay, some sand, trace of gravel.
11-LS	516.5	Soft to Plastic	8	12	24.9	99.2	11-LS: Uniform. Silty gray clay, some sand, trace of gravel.
12-LS	511.5	Plastic	10	12	18.9	108.0	12-LS: Uniform. Silty gray clay, some sand, trace of gravel.
13-LS	506.5	Plastic	13	12	25.5	99.9	13-LS: Uniform. Silty gray clay, some sand, trace of gravel.
14-LS	501.5	Plastic	10	12	26.2	98.0	14-LS: Uniform. Silty gray clay, some sand, trace of gravel. Laminated.

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

W.L. Water Level at completion.

Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc.
Their Job No. HCB-12371-D
Date of Boring: April 10, 1967

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 34
ST. CLAIR POWER PLANT
THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN

APPROVED W.C. Housel DATE 6-14-67

PROJECT NO. 01994

LOG OF SOIL PROFILE

BY R.C.P. DIVISION

GROUND SURFACE ELEVATION = 579.4 Ft. (USC & GS DATUM)

ELEVATION IN FEET: 570, 560, 550, 540, 530, 520, 510, 500, 490

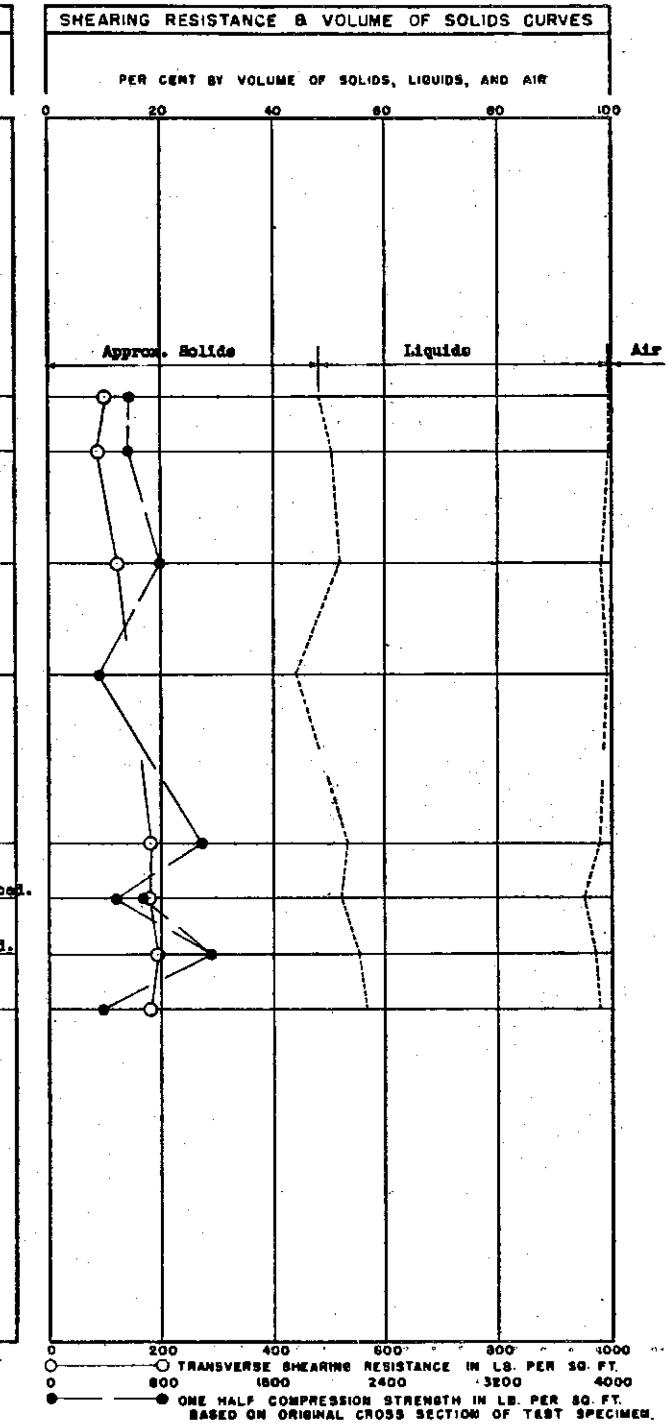
- Fill; Cinder.
- Fill; Loose Sand and Clay.
- W.L.
- Fill; Loose Fine Sand.
- Very Soft Gray Clay.
- Soft Gray Clay, Some Fine Sand, Little Gravel.
- Medium Sandy Gravelly Gray Clay, Pockets of Fine Sand.
- Boring Stopped.

SOIL SAMPLE / LABORATORY VISUAL INSPECTION

SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	PENETRATION DRIVE IN INCHES	% H_2O BY DRY WT.	DRY WT LB. PER CU FT.	REMARKS
1-BS	574.4	--	3	12			
2-BS	569.4	--	3	12			
3-BS	564.4	--	1	15			
4-BS	559.4	--	2	15			
5-LS	554.9	Soft	2	12	39.6	81.1	5-LS: Uniform. Silty gray clay.
6-LS	549.9	Soft	2	12	36.3	84.9	6-LS: Uniform. Silty gray clay.
	544.4	--	2	12			
7-LS	539.9	Soft	2	12	33.1	87.4	7-LS: Uniform. Silty gray clay, trace of fine sand and silt lenses.
	534.4	--	4	12			
8-LS	529.9	V.Soft	4	12	46.6	74.3	8-LS: Uniform. Silty gray clay, trace of very fine sand.
	524.4	--	8	12			
	521.9	--	8	12			
9-LS	519.4	--	8	12			
10-LS	514.9	Soft	7	12	30.9	89.9	10-LS: Uniform. Silty gray clay, some sand, trace of gravel.
11-LS	509.9	Soft	6	12	30.8	87.7	11-LS: Uniform. Silty gray clay, some sand, trace of gravel. Honeycombed.
12-LS	504.9	Soft	8	12	28.1	93.0	12-LS: Uniform. Silty gray clay, some sand, trace of gravel. Laminated.
13-LS	499.9	Soft	9	12	26.9	95.5	13-LS: Uniform. Silty gray clay, trace of sand.

PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES



Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc.
Their Job No. ECB-18371-D
Date of Boring: April 12, 1967

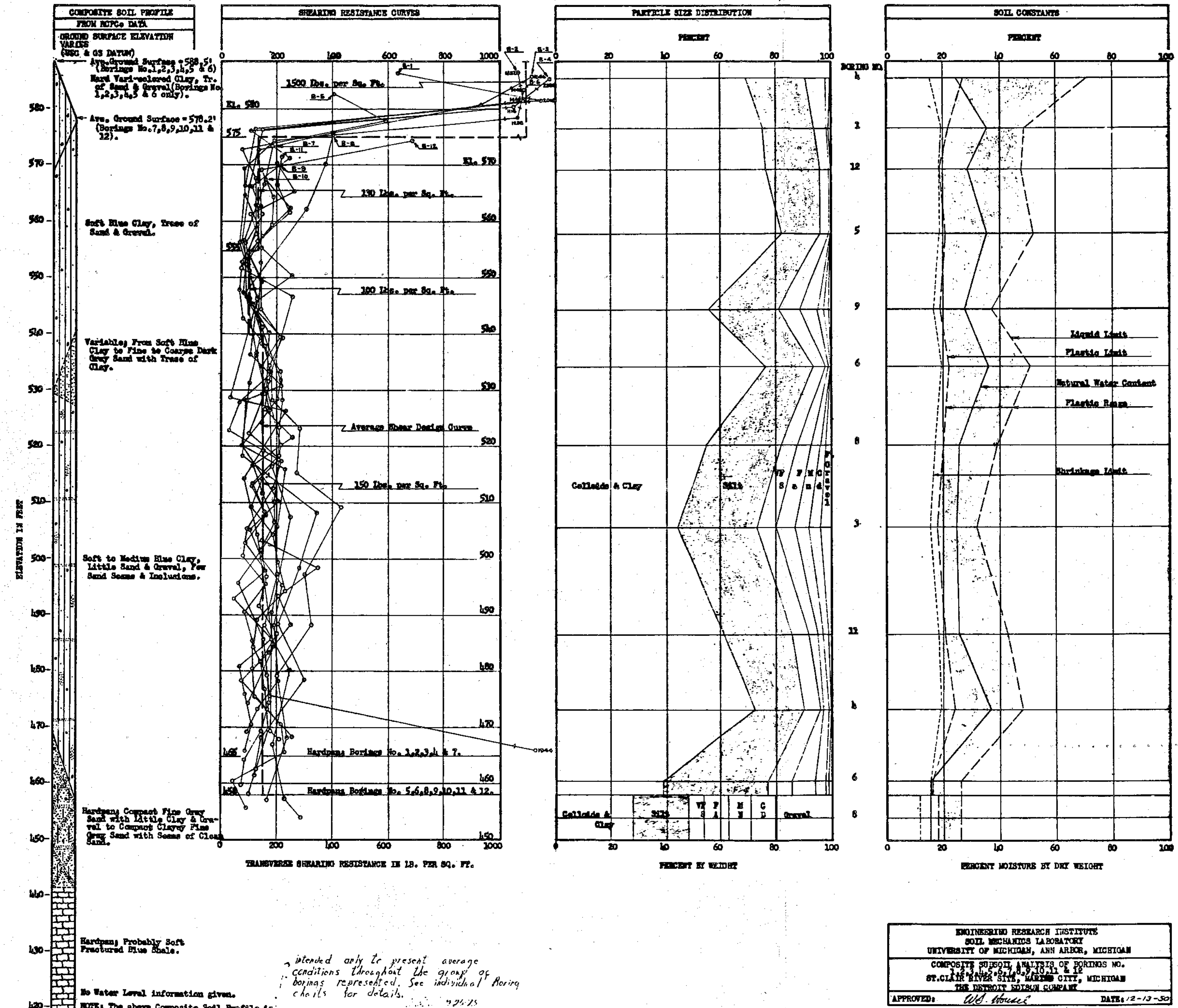
W.L. Water Level at Completion.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 35
ST. CLAIR POWER PLANT
THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN

APPROVED: W.S. Housel DATE 6-14-67

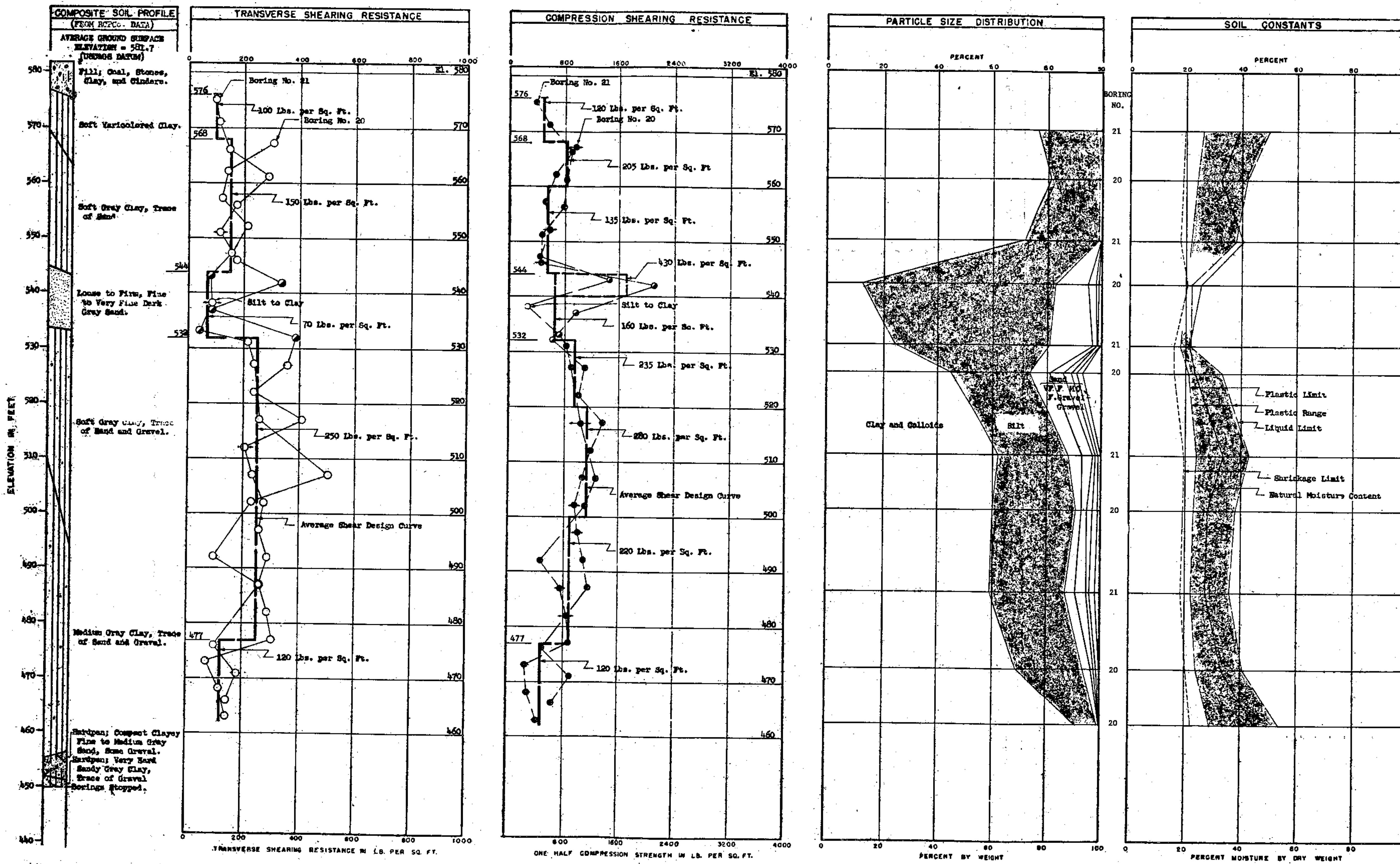
PROJECT NO. 01994



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 1,2,3,4,5,6,7,8,9,10,11 & 12
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.S. Housel DATE: 12-13-50



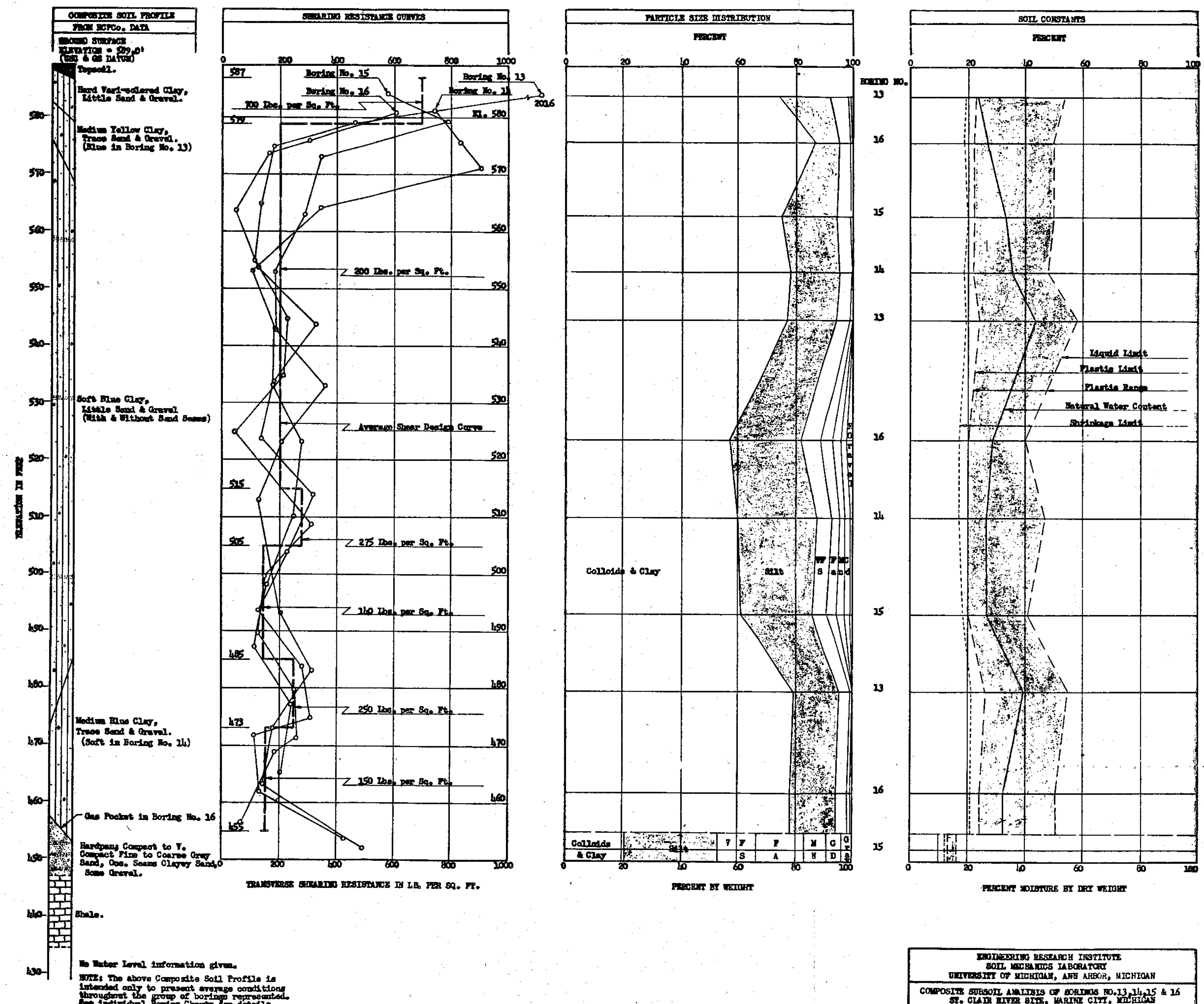
NOTE: The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual boring charts for details.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 20 and 21
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN

APPROVED: W.K. Kusel DATE: 1-2-59

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01994

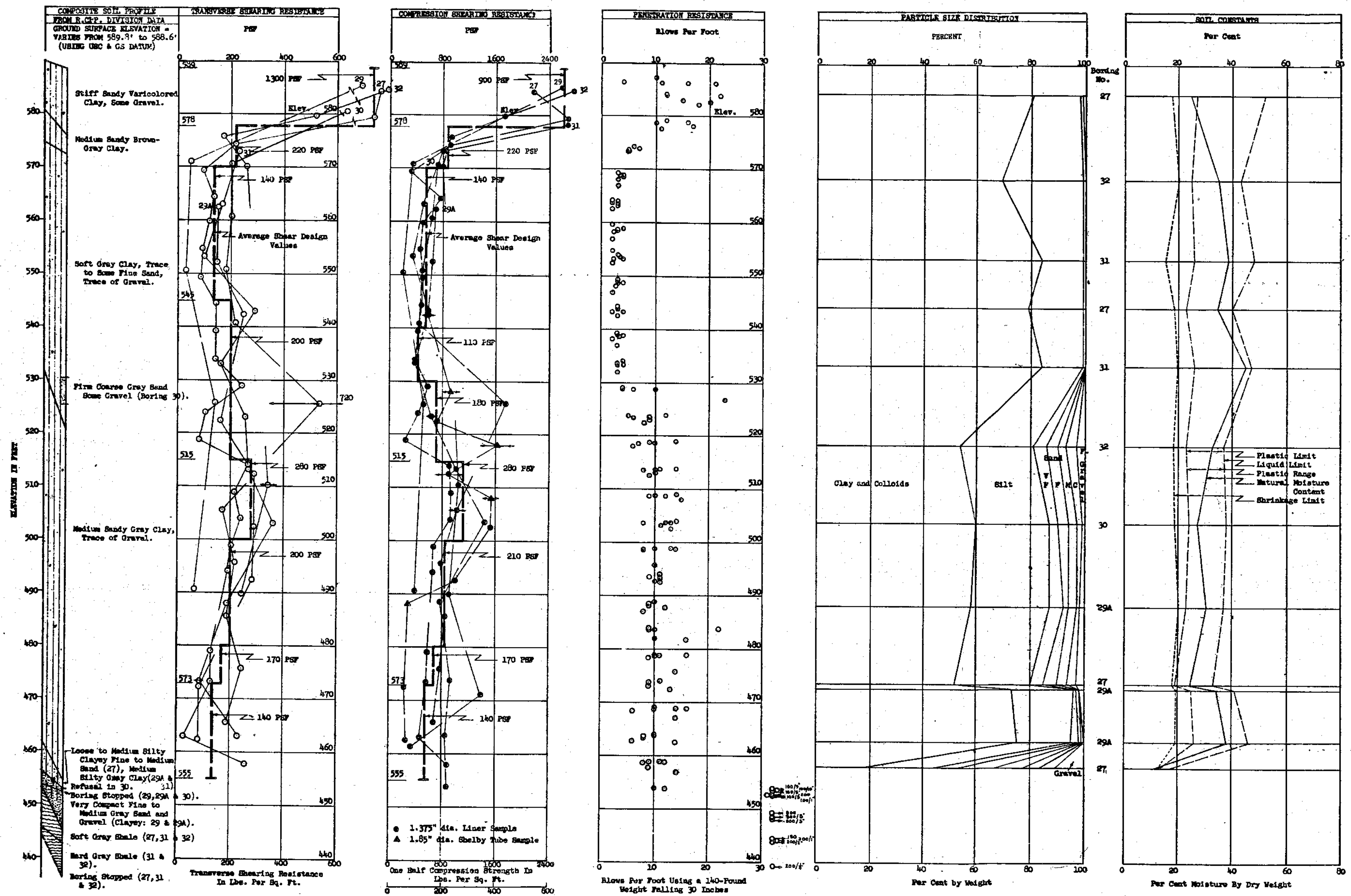


ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO.13,14,15 & 16
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: W.J. Housel DATE: 12-13-50

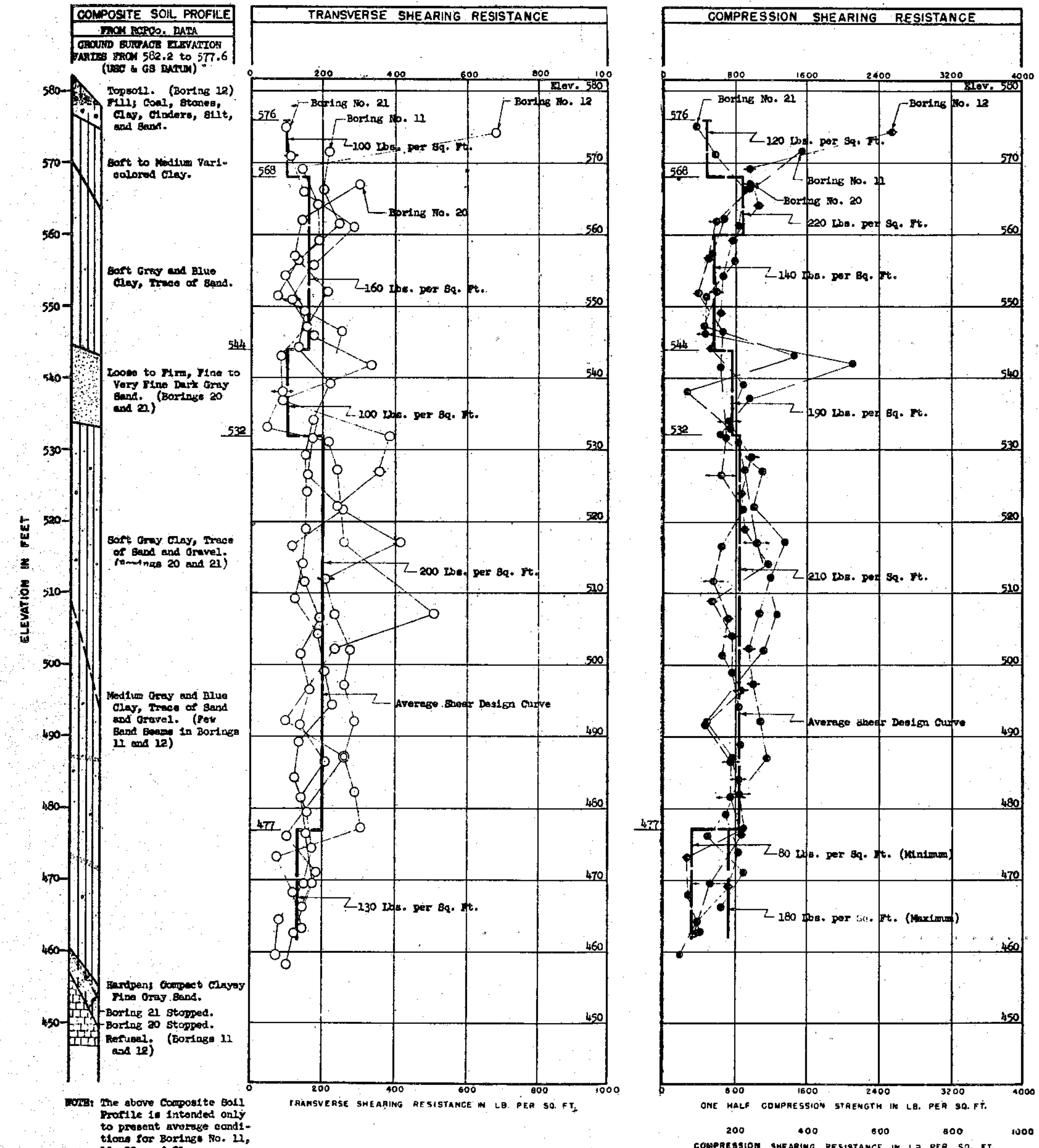
UNIVERSITY OF MICHIGAN PROJECT M373-66



The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.
Date of Borings: December 1966 to February 1967

OFFICE OF RESEARCH ADMINISTRATION SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NOS. 27, 29, 29A, 30, 31 AND 32 CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY BELLE RIVER, MICH.
APPROVED: W.S. Housel DATE: 6-14-67

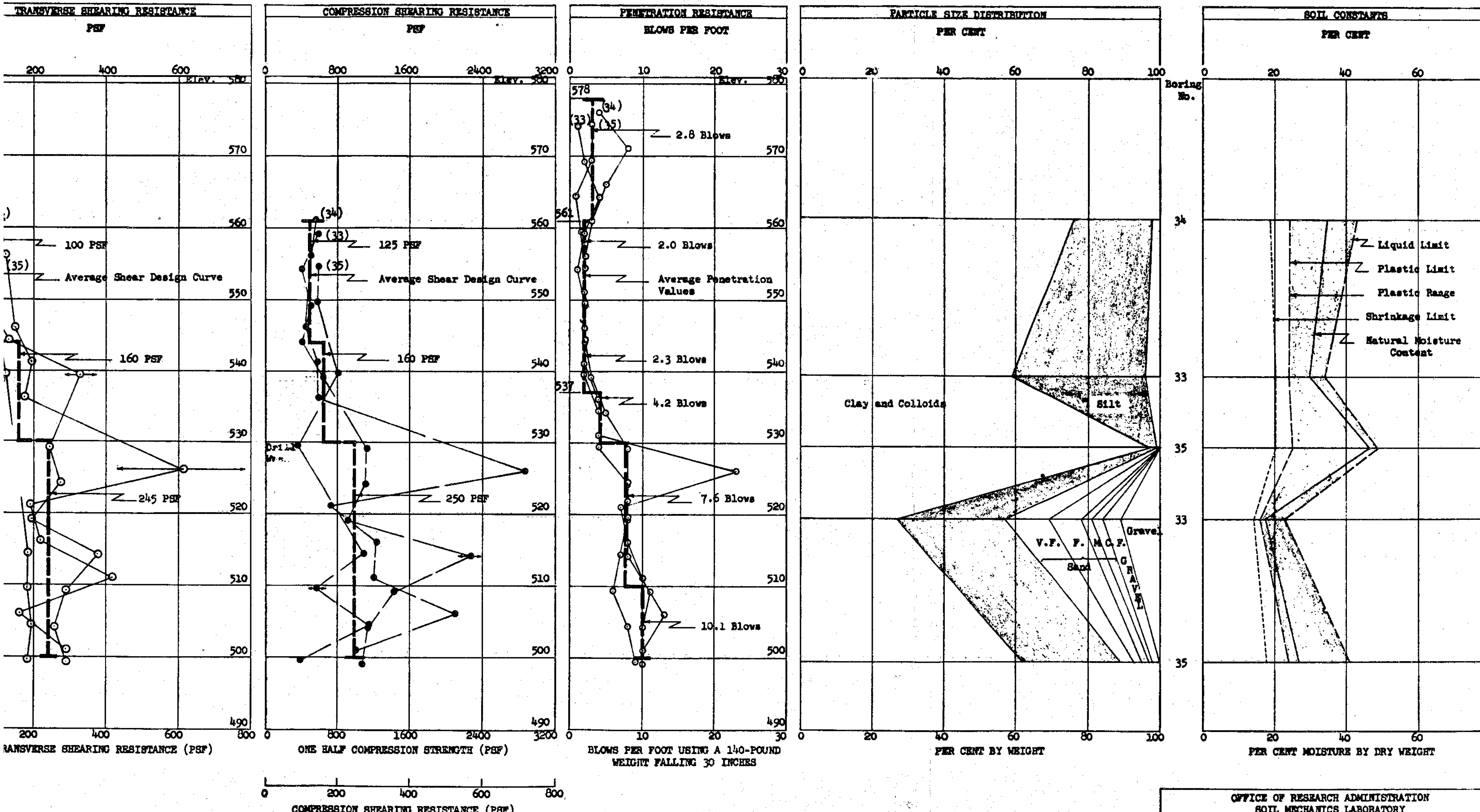
OFFICE OF RESEARCH ADMINISTRATION PROJECT: 01994



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 11, 12, 20 and 21
ST. CLAIR POWER PLANT -- DETROIT EDISON COMPANY
DETROIT MICHIGAN

APPROVED: DATE:



OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN — ANN ARBOR, MICHIGAN

COMPOSITE SUBSOIL ANALYSIS OF BORINGS NOS. 33, 34 & 35
ST. CLAIR POWER PLANT

THE DETROIT EDISON CO. — BELLE RIVER, MICHIGAN

APPROVED: W.S. Housel — DATE: 6-14-

PROJECT NO. 01994

TABLE OF DRILL HOLES

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
7	N 7,507 E 7,851	143.0	586.6	Observation Well	Rotary Wash, Standard Pen ASTM	None	10.0	4-25-74
8	N 7,495 E 8,304	165.1	586.5	Original Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None		
9	N 8,576 E 9,361	144.0	586.7	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
10	N 8,600 E 9,965	155.5	586.1	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None		
11	N 8,316 E 8,715	150.0	586.7	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
12	N 7,884 E 9,005	174.2	586.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	Shelby 9		
13	N 8,321 E 9,336	144.0	586.5	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
14	N 8,306 E 9,627	145.0	586.6	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 11 Osterberg 3		
15	N 8,320 E 9,786	142.0	586.2	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 6 Osterberg 6		
16	N 7,996 E 8,712	143.8	586.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
17	N 8,000 E 9,004	183.3	585.9	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 6		

NOTE: Borings 1-6 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
27	N 7,719 E 9,205	187.5	586.2	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 15		
28	N 7,724 E 9,443	193.5	585.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 10		
29	N 7,685 E 8,724	169.0	585.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None		
30	N 7,673 E 9,015	135.0	586.4	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
31	N 7,669 E 9,331	143.4	585.9	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
32	N 7,663 E 9,659	144.5	586.6	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None		
33	N 7,400 E 9,322	138.5	585.6	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 13		
34	N 7,398 E 9,963	158.17	586.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None		
37	N 9,006 E 11,987	133.0	588.0	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
38	N 9,007 E 13,035	153.0	598.3	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 11		

NOTE: Borings 35&36 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
49	N 3,695 E 12,440	155.0	586.6	Proposed Conveyor System	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 15		
50	N 2,951 E 15,471	153.75	581.8	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 10		
52	N 2,375 E 15,271	158.5	582.1	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core	Shelby 2 Osterberg 11		
53	N 2,052 E 15,176	154.91	580.6	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core	Shelby 8 Osterberg 5		
54	N 2,937 E 15,537	147.67	541.6	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core	Shelby 17 Osterberg 2		
55	N 2,645 E 15,506	100.0	547.9	Proposed Dock Area	Rotary Wash, Standard Pen ASTM	None		
56	N 2,296 E 15,399	102.0	547.5	Proposed Dock Area	Rotary Wash, Standard Pen ASTM	None		
57	N 1,907 E 15,247	120.2	548.3	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Osterberg, NX Core	Osterberg 1		
58	N 2,725 E 15,224	162.0	583.5	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, NX Core	None		

NOTE: Boring 51 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
105	N 4,979 E 10,998	160.3	588.3	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, Pitcher, Osterberg, NX Core	Shelby 4 Pitcher 2 Osterberg 6		
106	N 4,836 E 12,528	140.0	589.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
109	N 6,450 E 13,140	142.7	600.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
110	N 6,570 E 12,830	146.3	599.8	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 12 Osterberg 5		
111	N 6,600 E 11,000	140.0	588.5	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
112	N 6,824 E 8,900	160.5	587.0	Original Proposed Switchyard	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 3		
113	N 6,800 E 9,360	164.3	587.4	Proposed Switchyard	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 3		
114	N 6,980 E 13,360	144.2	599.5	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
115	N 7,100 E 13,060	144.0	600.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 14		
116	N 7275.71 E 8897.94	180.5	585.6	Benchmark	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 14		

NOTE: Borings 107&108 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
128	N 3,000 E 11,000	141.5	589.5	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
129	N 3,000 E 12,000	158.8	586.0	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Pitcher, Osterberg, NX Core	Pitcher 9 Osterberg 3		
130	N 9,014 E 4,993	145.0	595.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
131	N 9,400 E 6,000	105.0	589.9	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
134	N 10,050 E 4,995	128.5	594.6	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
135	N 10,050 E 6,000	70.0	591.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
136	N 10,050 E 7,000	130.0	590.2	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 3		
137	N 10,050 E 8,000	71.0	588.9	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
138	N 10,030 E 8,977	145.0	588.7	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
139	N 10,866 E 4,990	145.5	595.7	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
140	N 10,850 E 6,003	70.5	592.0	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		

NOTE: Borings 132&133 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type U.D. Samples Taken	Ground Water Level[1] Depth(ft)	Date
154	N 13,785 E 8,000	165.0	599.0	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
155	N 14,001 E 5,996	70.0	601.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
157	N 14,000 E 8,000	70.0	591.5	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
158	N 14,000 E 9,000	130.0	589.6	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 4		
159	N 14,000 E 9,950	70.0	591.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
160	N 14,522 E 4,880	159.0	595.5	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
163	N 15,000 E 8,000	138.0	591.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
164	N 15,000 E 9,000	70.0	591.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
165	N 14,830 E 9,938	156.5	594.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
180	N 2,925 E 12,180	140.0	588.0	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
181	N 3,525 E 12,533	144.0	590.8	Observation Well	Rotary Wash, Standard Pen ASTM	None	10.0	4-25-74

NOTE: Borings 152,153,156,161,162 and 165-179 not drilled.

CONSISTENCY OF COHESIVE & SEMI-COHESIVE SOILS

V. Soft
Almost completely lacks resistance to external forces causing deformation.
Will slump or deform of its own weight.
When squeezed in fist, it will riboon or ooze out between fingers.
Sometimes referred to as "toothpaste" consistency.
Moisture content near or above liquid limit (wet).

Soft
Only slightly resistant to external forces causing deformation.
Will support its own weight.
When squeezed in fist, impression of fingers is marked and soil will squeeze between fingers.
Can be molded to any shape without resistance.
Mositure content well above plastic limit (very moist).

Medium (Plastic)
May be deformed readily without rupture.
When squeezed in fist, impression by fingers will be pronounced but it will not squeeze.
Can be molded to any shape, but offers some resistance--will probably "check" or crack slightly.
Moisture content slightly above plastic limit (moist).

Firm
Moderately resistant to external forces causing rupture.
Lumps or cores can be broken by fingers.
When squeezed in fist, impression by fingers is slight. No tendency to squeeze.
Will rupture and lose structure if molding is attempted from original shape. Once structure is lost, however, it can be molded or "packed."
Moisture content near the plastic limit (damp to moist).

Stiff
Resistant to external forces causing deformation.
Lumps or cores can be broken by fingers.
When squeezed in fist, or pressed by thumb, indentation by fingers is only slight regardless of pressure applied.
Cannot be molded from original shape.
Moisture content near the shrinkage limit (damp).

Hard
Very resistant to external forces causing deformation.
Lumps or cores can be broken by fingers, but with difficulty.
Cannot be indented by fingers or thumb, but can be scored readily by fingernail.
Moisture content below the shrinkage limit (dry).

V. Hard
Extremely resistant to external forces causing deformation.
Lumps or cores cannot be broken by fingers.
Cannot be indented by fingers or thumb; can be scored only slightly by fingernail.
Moisture content below the shrinkage limit (dry).

CONSISTENCY OF GRANULAR SOILS (by standard penetration index)

V. Loose	-- 0-4 blows
Loose	-- 5-10 blows
Medium Compact	-- 11-25 blows
Compact	-- 26-50 blows
V. Compact	-- 50+ blows

LOCATION: N 7,495 E 8,304

GROUND ELEVATION 586.5

DATE DRILLED: 11-26-73 12-3-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

NO UNDISTURBED SAMPLES TAKEN

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

No. blows per foot: 25, 31, 10, 3, 2, 18, 2, 2, 2, 3, 4, 11, 7, 10, 8, 12, 13, 14, 15, 10, 11, 15, 15, 8, 7, 10, 37, 28, 40, 100+, 100+

% Core recovery: 74

DESCRIPTION

- black clayey Topsoil (OH)
- med. mottled brown & gray, silty Clay (CL) trace of sand
- stiff to hard, gray, silty, some sand and gravel
- stiff, gray, silty, trace of sand, few pebbles
- very soft to soft, gray, silty, trace of fine sand
- med., gray, silty, some sand & pebbles
- soft, gray, silty, trace of sand & gravel
- fine silty Sand (SC) & seams of med. gray silty clay
- compact, gray, clayey silty Sand (SM-SC)
- compact, gray, silty fine Sand (SM)
- same, some gravel & clay
- 15 gallon water loss at 146.5 & 150.5ft
- compact, gray, sandy Gravel (GC) some clay
- 154.0 - 165.1ft Shale, dark gray, soft

Bottom of Hole-Elevation-421.4
-Depth-165.1ft

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite slurry in soil and cement in rock.

SOIL BORING NO. 8

BECHTEL Belle River

LOCATION: N 8,600 E 9,965

GROUND ELEVATION 586.1

DATE DRILLED: 11-9-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL—LL) 0 10 20 30 40 50 60 70 80

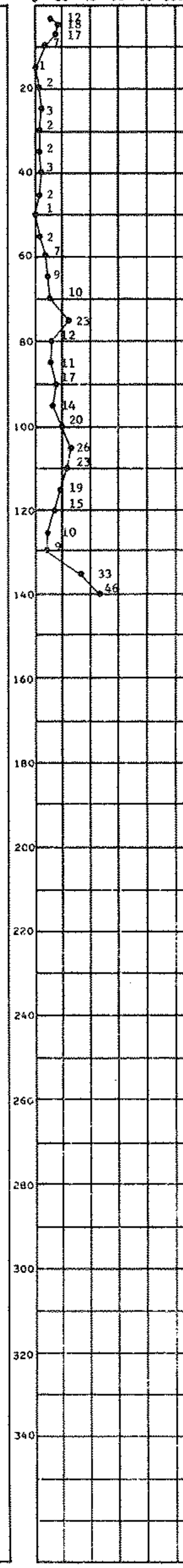
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE



% CORE RECOVERY

SYMBOL

DEPTH IN FEET

DESCRIPTION

black, clayey Topsoil (OH) some roots

firm to stiff, mottled brown & gray, Clay (CL) streaks of sand & gravel

firm, silty brown

soft to plastic, gray silty Clay (CH)

very soft

soft, trace of fine sand

plastic

plastic to firm, trace of very fine sand

soft

soft to plastic, some silty & very fine sand parting

Dark gray, silty Clay (CL-ML) low plasticity

90

99

141.3-155.5ft Shale, black, slightly micaceous, abundent clay seams, 153.0-154.0ft contorted bedding.

Bottom of Hole-Elevation-430.6
-Depth-155.5ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil in soil and cement in rock.

SOIL BORING NO. 10

BECHTEL

Belle River

LOCATION: N 7,884 E 9,005

GROUND ELEVATION: 586.8

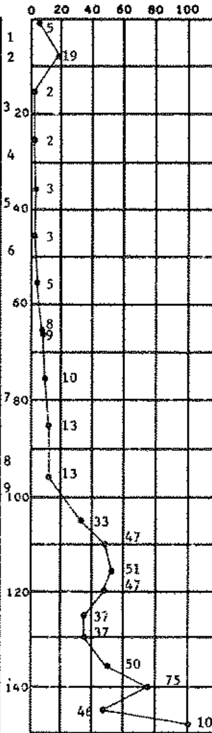
DATE DRILLED: 2-11-74 2-18-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	CORE RECOVERY	SYMBOL	DESCRIPTION

DEPTH IN FEET

SAMPLE TYPE: SHELBY TUBES (samples 1–9)



CORE RECOVERY: 100, 81, 100

DESCRIPTION

- bottom ash, fill
- clayey topsoil
- soft, brown, silty Clay (CL), trace fine sand
- stiff, some fine sand
- very soft to soft, gray, silty Clay (CH)
- plastic, gray, silty Clay (CL) some fine sand
- fairly compact, gray, very fine sandy Silt (SM)
- compact, gray, fine Sand (SP)
- trace gas at 118.0ft
- compact, fine to medium, gray Sand (SW) trace coarse sand
- compact, gray, gravelly, medium Sand(SW) pieces broken Shale
- 146.0 - 174.2ft Shale, dark gray to gray, soft to moderately firm, fractured, horizontal bedding, scattered silty seams
  - 154.2 - 154.9 light gray silty seam
  - 154.9 - 155.5 gray, silty clay seam
  - 160.5 - 162.2 local bedding dips 20°

Bottom of Hole-Elevation-412.6
-Depth-174.2ft

Water loss of 20 gallons in sand.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil in soil and cement grout in rock.

SOIL BORING NO. 12

BECHTEL Belle River

DUNN 10-72

LOCATION: N 8,306 E 9,627

GROUND ELEVATION 586.6

DATE DRILLED: 1-28-74 1-31-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100 120		

Sample numbers: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

Sample type: SHELBY TUBES | OSTERBERGS

Blows per foot: 7, 18, 2, 2, 4, 5, 6, 13, 17, 19, 17, 28, 31, 18, 19, 49, 65

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

DESCRIPTION

cinders, Topsoil

plastic, brown & gray, silty Clay (CL) some topsoil

firm, brown, some fine sand

very soft to soft, gray, silty Clay (CH)

plastic, gray, silty Clay (CL) some fine sand

medium compact, gray, clayey Sand (SC)

plastic, gray, silty Clay (CL), few sand lenses or pockets

plastic to firm, some very fine sand

soft, trace fine sand

compact, gray, fine Sand (SP)

firm, gray, clayey Silt (ML)

144.5 - 145.0ft Shale, gray, soft

Bottom of Hole-Elevation-441.6
-Depth-145.0ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil.

SOIL BORING NO. 14

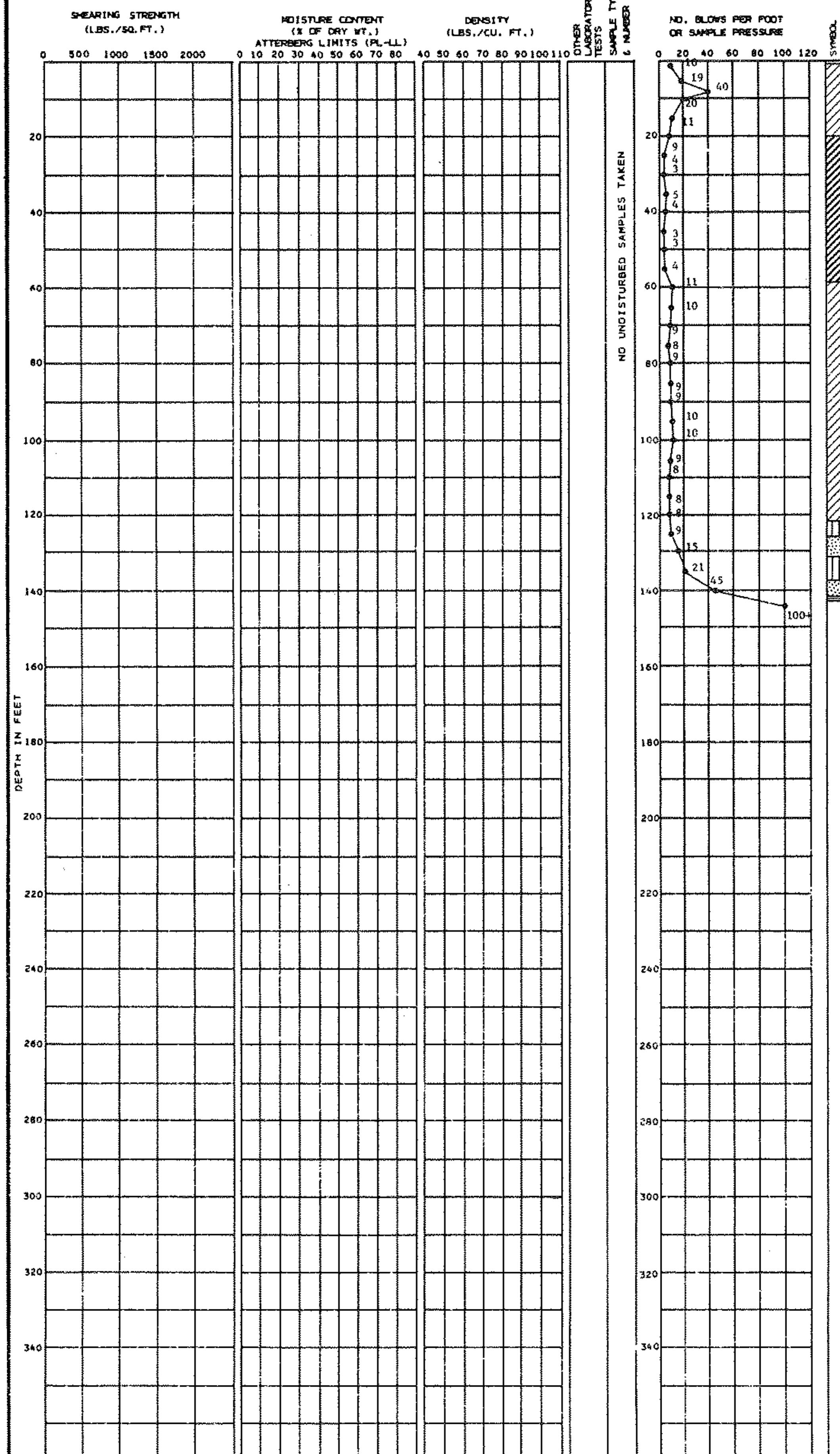
BECHTEL Belle River

LOCATION: N 7,996 E 8,712

GROUND ELEVATION 586.0

DATE DRILLED: 2-12-74 2-14-74

SHEET 1 OF 1



DESCRIPTION

Cinders, bottom ash

Firm, brown & gray, silty <u>clay</u> (CL) some fine sand

Stiff, brown

Plastic, gray, trace fine sand

Very soft to soft, gray, silty <u>clay</u> (CH)

Plastic, gray, silty <u>clay</u> (CL) some fine sand

Medium compact, gray, clayey <u>silt</u> (ML)

Compact, gray, very fine <u>sand</u> (SP)

Compact, gray, <u>silt</u> (ML) some fine sand

Compact, gray, very fine to medium <u>sand</u> (SW)

142.0-143.75 ft. <u>shale</u>, gray, soft

Bottom of hole - Elevation - 442.25
- Depth - 143.75 ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil.

SOIL BORING NO. 16

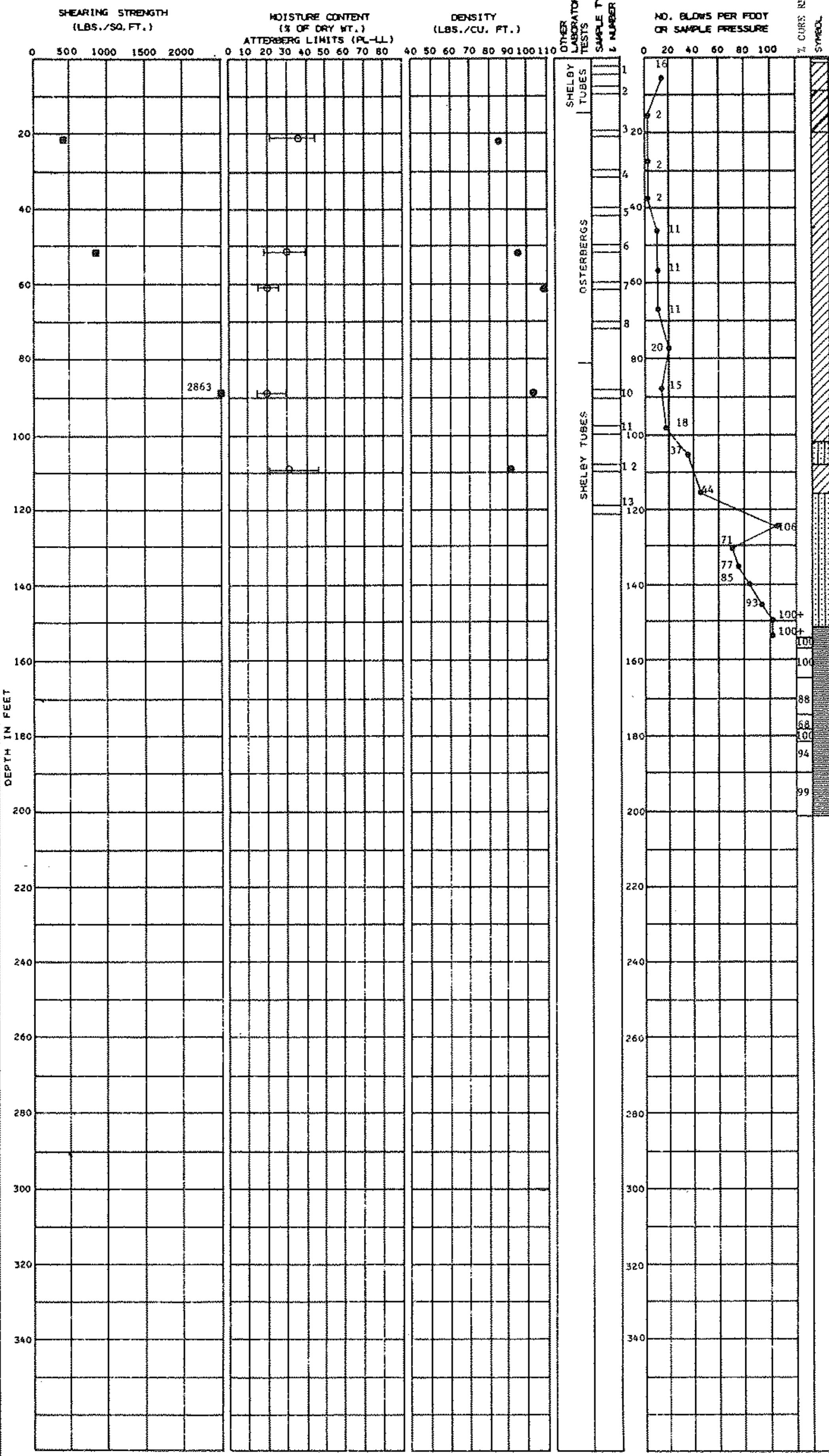
BECHTEL Belle River

LOCATION: N 8,081 E 9,193

GROUND ELEVATION 586.0

DATE DRILLED: 1-16-74 1-29-74

SHEET 1 OF 1



DESCRIPTION

- fill, cinders
- peaty topsoil
- firm to stiff, brown, silty Clay (CL) trace fine sand
- very soft to soft, gray silty Clay (CH-CL)
- soft to firm, moderate to high plasticity, dark gray, silty Clay (CL) trace fine to coarse sand and gravel
- firm to stiff, moderately plastic, trace fine sand
- 30% fine to coarse sand
- plastic to firm, few pebbles
- very stiff, moderate plasticity, some fine to coarse sand and gravel
- few sand seams
- Silty Sand (SM-SW) fine to coarse sand grains with trace fines
- stiff, moderate to high plasticity, gray, silty Clay (CL) lenses of silty sand (30% of sample)
- 25 gallons water lost at 130ft
- silty Sand (SM) some fine to coarse sand and gravel, little fines
- 152.0 - 201.0ft Shale, gray, horizontal bedding, moist to dry
  - 152.0 - 156.0ft soft, interbedded shale and clay seams
  - 156.0 - 201.0ft firm to very firm, fractured to solid, silty seams
  - 156.0 - 159.8ft Quartz veins

Bottom of Hole-Elevation-385.0
-Depth-201.0ft

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite in soil and cement grout in rock.

■ Unconsolidated Undrained

├─┤ Atterberg Limits

○ Moisture Content

SOIL BORING NO. 18

BECHTEL Belle River

LOCATION: N 8,011 E 9,337

GROUND ELEVATION: 586.5

DATE DRILLED: 1-17-74 1-23-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

Sample type: SHELBY TUBES

Sample numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

No. blows per foot: 6, 26, 4, 4, 3, 4, 5, 7, 13, 16, 25, 13, 17, 19, 52, 100+

% Core recovery: 25, 96, 90

DESCRIPTION

- bottom ash fill
- Topsoil
- plastic, brown, silty Clay (CL), trace sand
- firm, brown & gray
- very soft to soft, gray, silty Clay(CH)
- plastic to firm, gray, silty Clay (CL) some fine sand, trace pebbles
- firm, few pebbles
- plastic, trace fine sand
- medium compact, fine sandy Silt (ML), trace clay
- medium compact, very fine Sand (SP), trace silt, trace gas at 136.0ft
- 136.5 - 145.8ft Shale, gray, soft, disintegrated, moist, silty
- 145.8 - 147.9ft Sand gray, fine to medium grain, clayey
- 147.0 - 164.3ft Shale, gray, firm, fractured, horizontal bedding, dry 147.0 - 152.8ft soft, fractured to disintegrated

Bottom of Hole-Elevation-422.2
-Depth-164.3ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil in soil and cement grout in rock.

SOIL BORING NO. 20

BECHTEL Belle River

DUNN 10-73

LOCATION: N.8,002 E.9,943

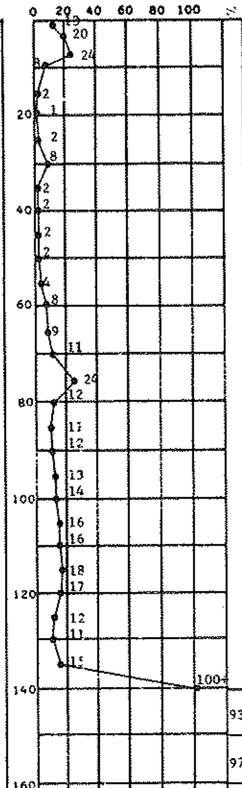
GROUND ELEVATION 585.9

DATE DRILLED: 11-20-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100	% CORE RECOVERY	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN				

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

black clayey Topsoil (OH)

firm to stiff, mottled brown, silty Clay (CL) trace of sand.

plastic, gray, silty, some fine sand

very soft gray silty Clay (CH)

plastic, dark gray sandy Clay (CL) some pebbles.

soft, gray silty Clay (CH)

soft to plastic gray silty Clay (CL) some fine sand

med., gray, silty some sand & gravel

med., gray, silty

trace of sand, a few pebbles

med. gray silty Clay (CH)

Slight to low plasticity, dark gray, clayey Silt (CL-ML)

138.5-160.5ft Shale, black, slightly micaceous, highly weathered to a depth of 140.75ft, crumbles easily.

Bottom of Hole-Elevation-425.4
-Depth-160.5ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite slurry in soil and cement grout in rock

SOIL BORING NO. 22

BECHTEL Belle River

LOCATION: N 7,904 E 9,436

GROUND ELEVATION 586.3

DATE DRILLED: 1-30-74 2-5-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU.FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

Depth (ft)	Sample No.	Blows per foot
	2	4
	4	31
	6	2
20	8	3
40	10	3
	12	4
60	14	5
	16	12
80	18	10
	20	19
100	22	27
	24	15
120	26	15
	28	6
140	30	27
		60
		100+

SHELBY TUBES

% CORE RECOVERY: 100, 100

DEPTH IN FEET: 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

DESCRIPTION

cinders

sand, topsoil

soft, brown & gray, silty Clay (CL) trace very fine sand

stiff, brown, trace fine sand

very soft to soft, gray, silty Clay (CH)

▽ 4-25-74: Elevation of water-566.7 Depth of water-19.6 ft.

plastic, gray, silty Clay (CL) some fine sand

— firm

— soft to plastic

fairly compact, gray, clayey Silt (ML)

plastic, gray, silty Clay (CL) trace very fine sand

compact, gray Silt (ML) some very fine sand

142.0 - 164.0ft Shale, medium to dark gray, soft, disintegrated to fractured, horizontal bedding, with Quartz veins from 145.2 to 147.7, more firm below 154.0ft

Bottom of Hole-Elevation-422.3 -Depth-164.0ft

Piezometer Installation: cement backfill from 164.0' to 139.0', 5.0' of sludge pipe with bentonite around sludge pipe from 139.0' to 134.0', 4.0' of #80 Screen from 134.0' to 130.0' with sand pack around screen, 134.41' of 2" PVC from 130.0' to 4.41' above surface, backfill with bentonite around casing from 130.0' to ground surface.

For Water Table information consult Section 4.1.3.

SOIL BORING NO. 24

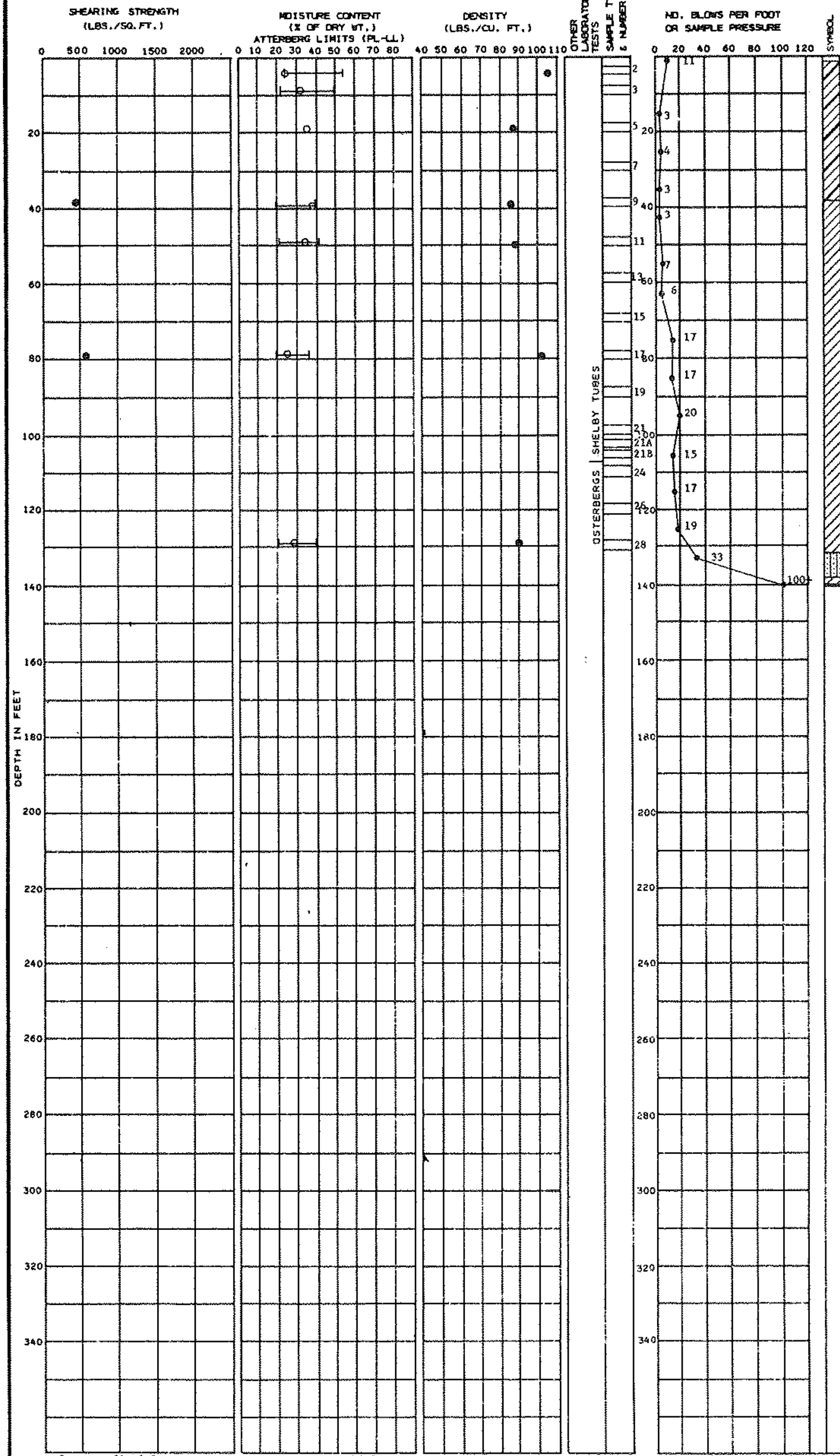
BECHTEL Belle River

LOCATION: N 7,890 E 9,763

GROUND ELEVATION: 585.6

DATE DRILLED: 12-12-73 12-19-73

SHEET 1 OF 1



DESCRIPTION

black sandy Topsoil

very stiff, moderate to high plasticity brown, silty Clay (CL-CH) some fine to coarse sand and fine gravel

firm, gray

— 15% fine gravel and coarse sand

Soft to firm, highly plastic, gray, silty Clay (CL)

— 20% fine to coarse sand

— firm to stiff, medium plasticity, 35% sand and gravel

— 30-40% fine sand & silt in thin layers

compact, gray, silty Sand (SM-SC) some clay

hard, gray Clay (CL) with shale, crumbles easily (Hardpan)

140.0-140.5 ft. Shale, soft, gray

Bottom of Hole - Elevation - 444.6
- Depth - 141.0 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite

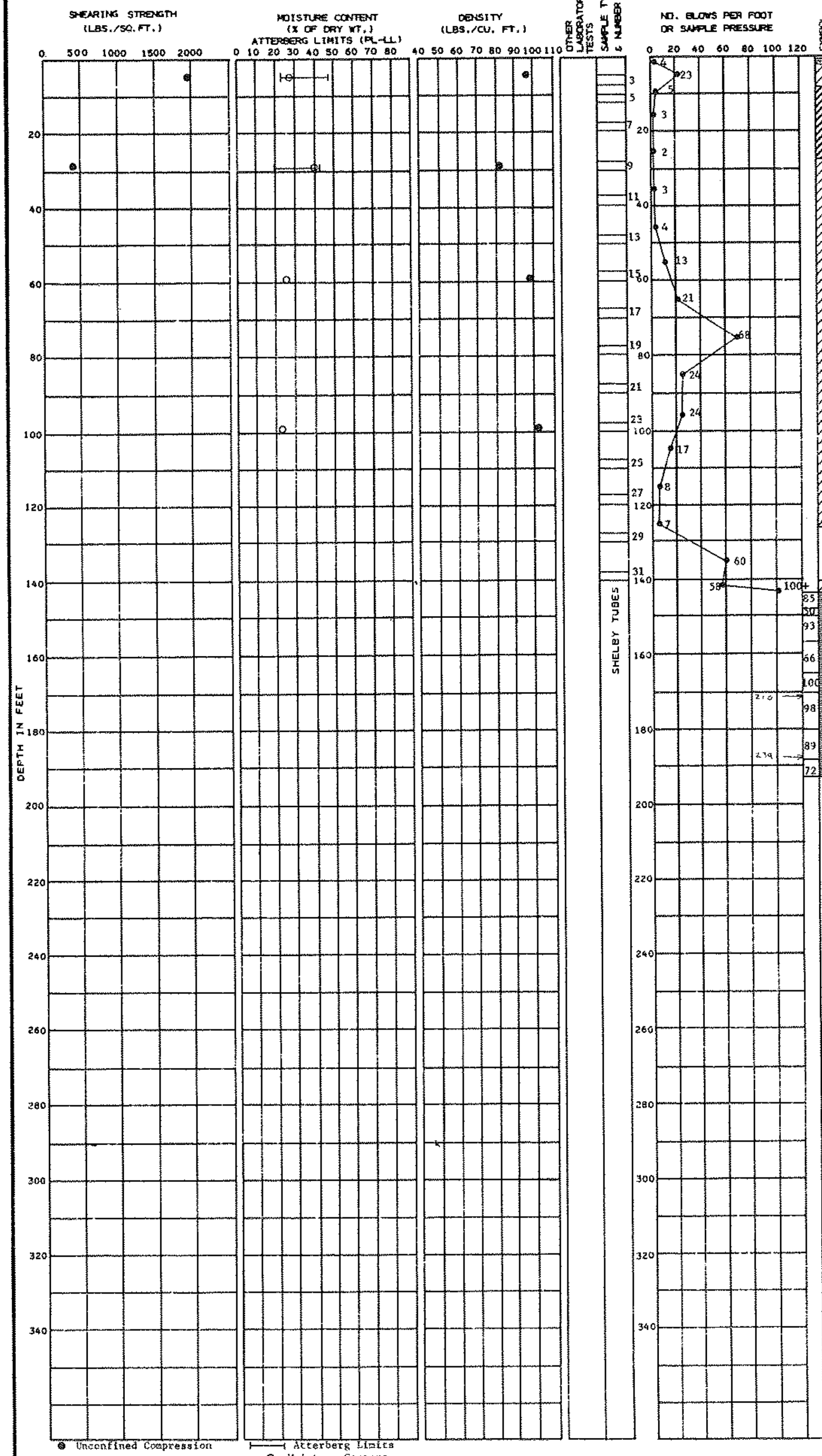
SOIL BORING NO. 26

BECHTEL Belle River

LOCATION: N 7,724 E 9,443 GROUND ELEVATION 585.8

DATE DRILLED: 1-15-74 1-22-74

SHEET 1 OF 1



DESCRIPTION

- cinders fill
- black sandy Topsoil
- brown, silty, fine Sand (SM)
- medium to stiff, brown & gray, silty Clay (CL) medium to high plasticity
- stiff
- soft, gray, silty Clay (CH)

soft, medium to high plasticity, gray silty Clay (CL)

- medium to stiff, medium plasticity, 15% fine to coarse sand
- very stiff, gray, silty fine sandy, with seams of fine sand, trace pebbles
- plastic to firm, gray silty, trace of fine sand
- stiff, 15% fine to coarse sand, medium to high plasticity

med. compact, clayey Silt (ML), trace of fine sand

hard, very sandy Clay (CL) some pebbles, some decomposed Shale (Hardpan)

143.8 - 193.5ft Shale, gray, soft to firm, disintegrated to fractured, moist to dry, horizontal bedding

Bottom of Hole-Elevation-392.3
-Depth-193.5ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and natural soil in soil and cement grout in rock.

SOIL BORING NO. 28

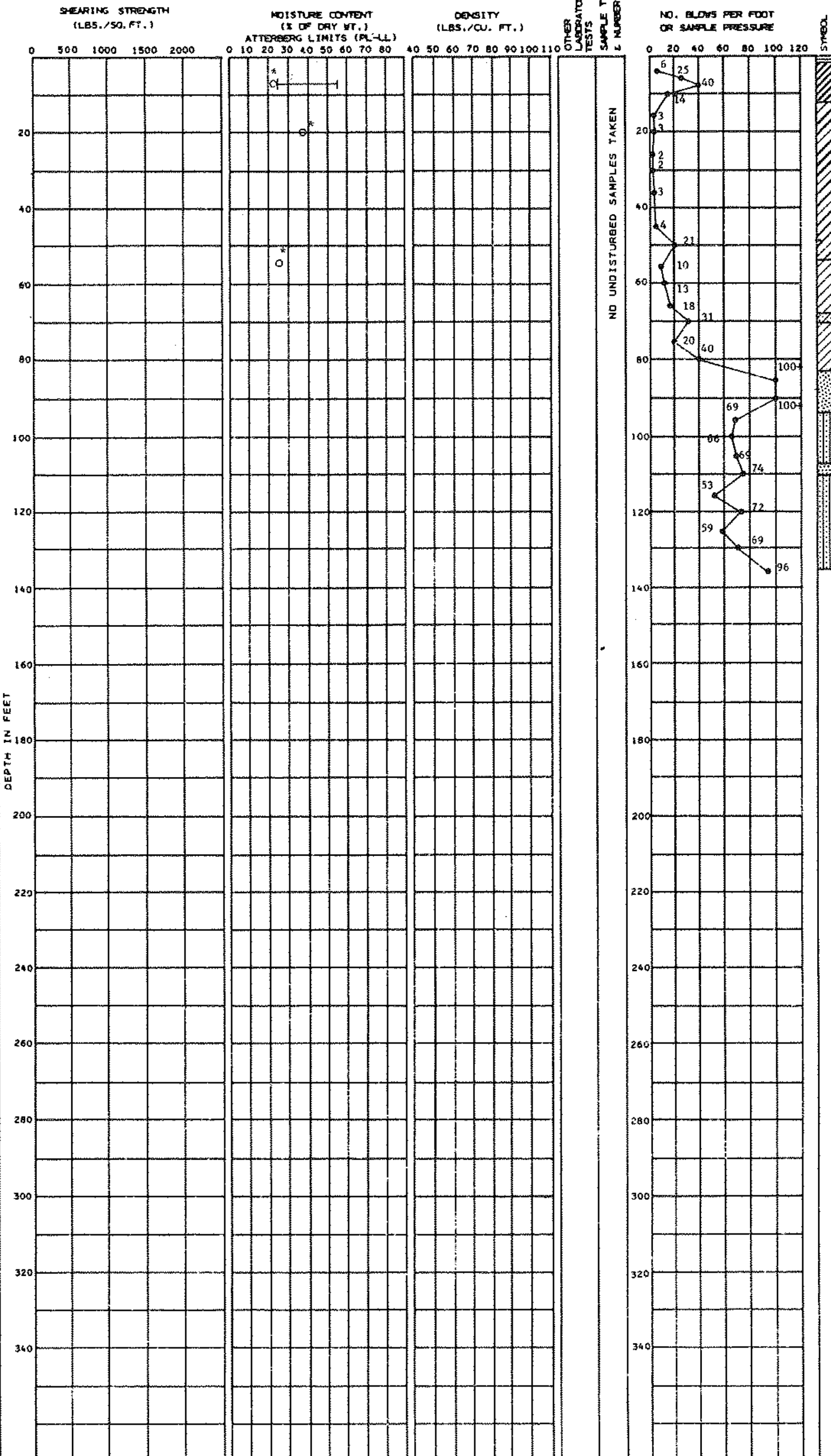
BECHTEL Belle River

LOCATION: N 7,673 E 9,015

GROUND ELEVATION 586.4

DATE DRILLED: 2-7-74 2-11-74

SHEET 1 OF 1



DESCRIPTION

Cinders, fill

Sandy topsoil

Soft, brown & gray, silty Clay (CH) trace fine sand, high plasticity

Stiff, brown, some fine sand

Very soft to soft, gray, silty Clay (CH-CL)

Firm, gray, sandy clay layer

Gray, silty Clay (CL) medium plasticity, 20% fine to coarse sand

Stiff, dark, gray clayey sand (SC)

Firm to stiff, gray, silty clay (CL), silt lenses

Hard, some fine sand

Compact, gray, fine sand (SP)

silty fine sand (SM) 15% nonplastic fines

Compact, gray, very fine to coarse sand (SW)

Silty sand (SM) 15% nonplastic fines

Bottom of hole - Elevation - 451.4
- Depth - 135.0 ft

This hole stopped at 135.0 ft. due to gas.

With casing at 110.0' no gas. Casing pulled to 57.0'. No gas. Pulled to 50.0', gas bubbling in hole. Capped hole and left for 48 hours. After 48 hours no gas (pocket only)

2-8-74 No gas
2-11-74 Gas
2-11-74 Pulled to 50.0', capped
2-11-74 1400 hours removed cap (no gas)

82.5' - 107.0' used Gel to keep open

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel in soil

⊢—⊣ Atterberg Limits
O Moisture Content
* Sample Jar Unsealed

SOIL BORING NO. 30

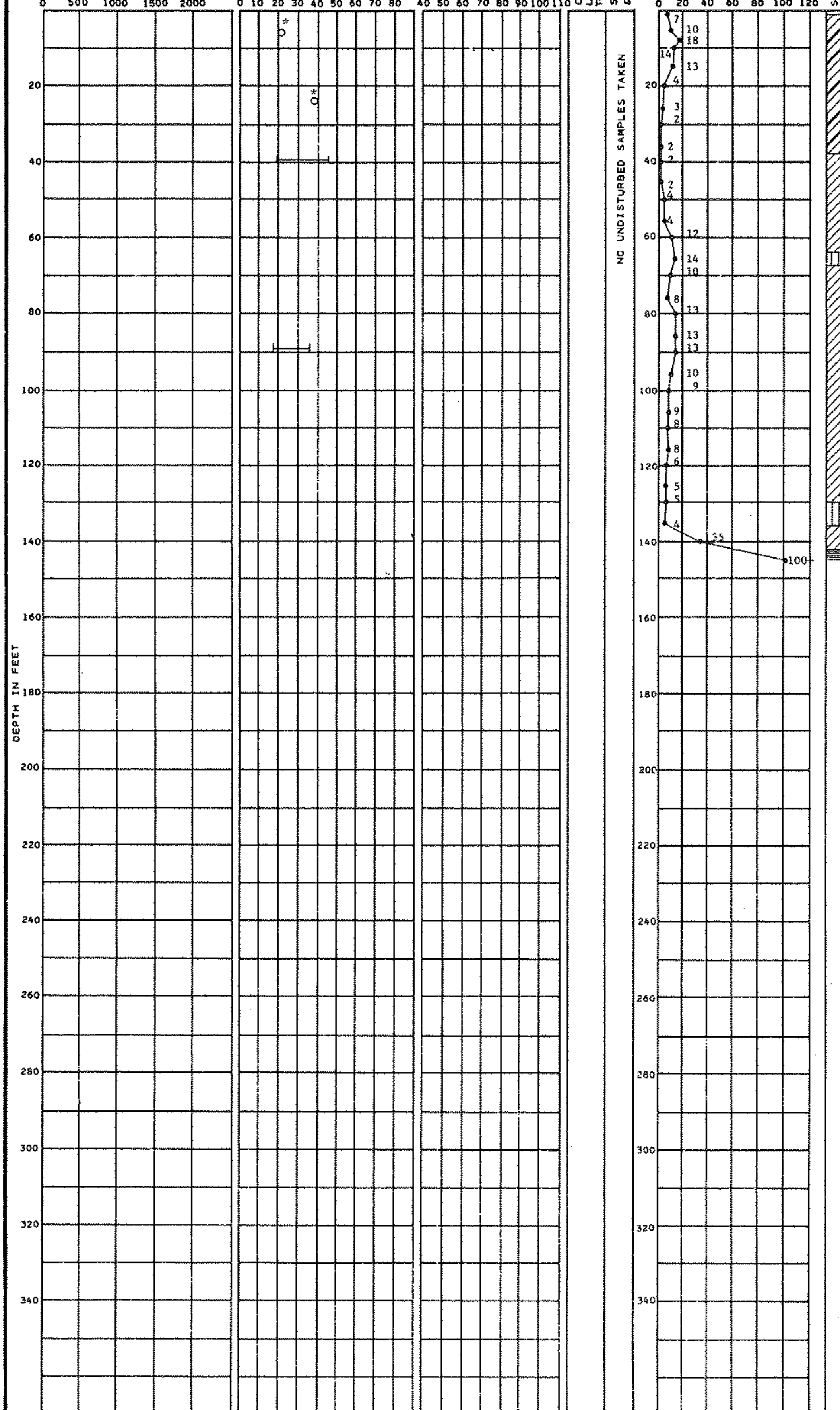
BECHTEL Belle River

LOCATION: N 7,663 E 9,659 GROUND ELEVATION 586.6

DATE DRILLED: 2-6-74 2-12-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	SYMBOL	DESCRIPTION



cinders, fill
medium stiff, brown & gray, silty Clay (CL-CH) highly plastic, trace fine sand
very stiff, brown
plastic, gray, some fine sand
same, sandy
very soft to soft, gray, medium to high plasticity

Gray, silty Clay (CL) medium to high plasticity

plastic, fine sand lenses

medium compact, gray, clayey Silt (ML)
plastic, gray, silty Clay (CL) some fine sand

10% fine to coarse sand

soft, trace fine sand

fairly compact, gray, clayey Silt (ML)

very stiff, gray, silty Clay (CL) sandy, few pebbles

142.0 - 144.5ft Shale, gray, soft

Bottom of Hole-Elevation-442.1
-Depth-144.5ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil.

├──┤ Atterberg Limits
O Moisture Content
* Sample Jar Unsealed

SOIL BORING NO. 32

BECHTEL Belle River

LOCATION:	N 7,398 / E 9,963
GROUND ELEVATION	586.0
DATE DRILLED:	11-8-73
SHEET	1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

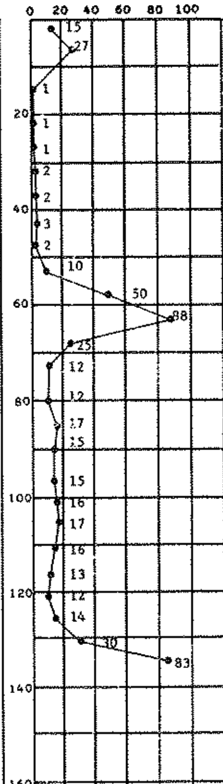
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE



% CORE RECOVERY: 88, 87

SYMBOL

DEPTH IN FEET

DESCRIPTION

black clayey Topsoil (OH) some sand

firm, gray & brown, silty Clay (CL) trace of sand

firm, gray, silty Clay (CH) very soft to soft

firm to stiff, gray, fine sandy Clay (CL) silt seams

compact, gray, medium silty Sand (SM-SC) some silt, trace of clay.

plastic to firm, gray silty Clay (CL) a few sand & silt pockets

soft to plastic, gray, silty Clay(CH) trace of fine sand

medium compact, clayey Silt (ML) some fine sand, trace of pebbles

hard, gray, sandy Clay (CH) trace of shale fragments

137.5-158.2ft Shale, black, slightly micaceous, highly weathered to a depth of 142.5ft, some clay seams.

Bottom of Hole-Elevation-427.83
-Depth-158.17ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel in soil and cement grout in rock.

SOIL BORING NO. 34

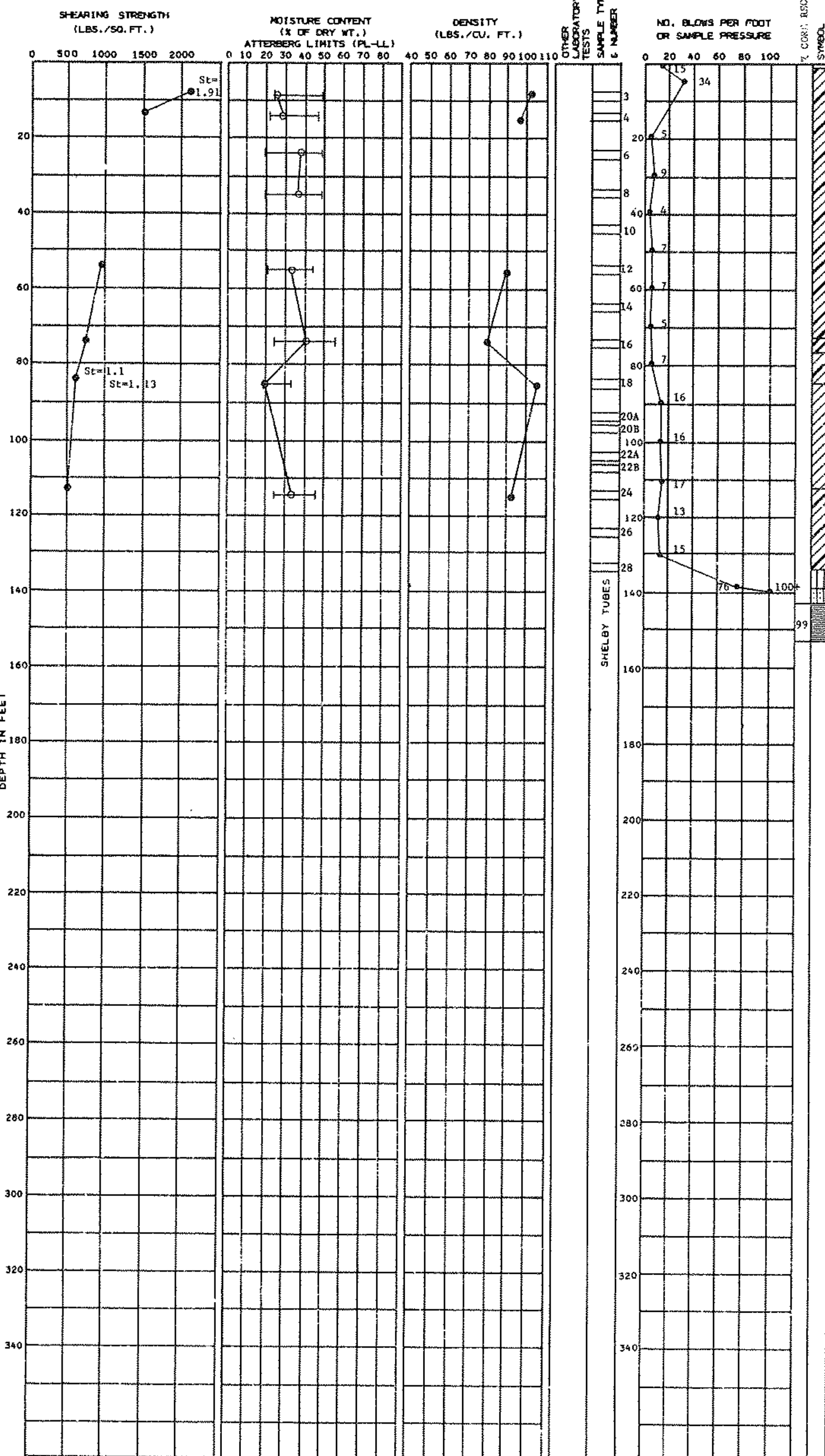
BECHTEL Belle River

LOCATION: N 9,007 E 13,035

GROUND ELEVATION 598.3

DATE DRILLED: 12-6-73 12-12-73

SHEET 1 OF 1



DESCRIPTION

black sandy Topsoil (OH)

silty Clay (CL-CH)
- firm, brown, some sand
- hard, highly plastic, dark grayish brown mottled, trace sand & fine gravel
- medium to very stiff
- soft, gray
- dark gray, high plastic, (sample greatly disturbed)
- (sample greatly disturbed)
- medium, highly plastic

medium stiff, dark gray, silty Clay (CH) highly plastic

plastic, gray, silty Clay (CL-CH) trace sand, few pebbles

stiff, moderate plasticity, dark gray, silty Clay (CL) 10% medium to coarse sand, 15% gravel
- firm, trace of sand & pebbles

soft to medium, moderately to highly plastic, gray, silty Clay (CL-CH) trace sand

compact, gray, fine sandy Silt (ML) some clay

compact, gray, silty fine Sand (SM) some pebbles , 30% nonplastic fines

143.0-153.0ft Shale, black, soft, micaceous, trace of pebbles, crumbles easily

Bottom of Hole-Elevation-445.3
-Depth-153.0ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel in soil and cement grout in rock.

● Unconfined Compression
St = Sensitivity

├─┤ Atterberg Limits
O Moisture Content

SOIL BORING NO. 38

BECHTEL Belle River

LOCATION: N 8,003 E10,993

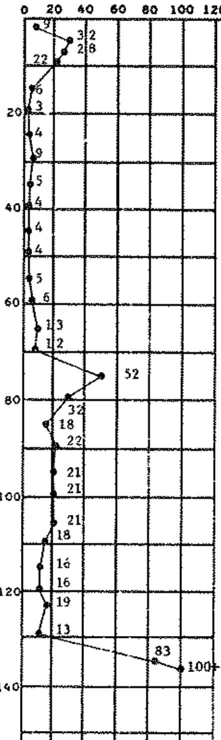
GROUND ELEVATION 589.1

DATE DRILLED: 12-14-73 12-18-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

black clayey Topsoil (OH)

med., brown, silty Clay(CL) trace sand

loose, brown, silty Sand (SM) trace pebbles

stiff, brown & gray, silty Clay (CL) trace sand

▽ 4-25-74: Elevation of water-580.8
Depth of water-8.3 ft.

stiff, gray, trace sand

soft

very soft, gray silty Clay (CH)

plastic, gray, silty Clay (CL), trace sand & pebbles

stiff, gray, sandy, silty, some pebbles

med. gray, silty, some fine sand, few pebbles

plastic to firm, gray, silty trace fine sand & pebbles

gray sandy Silt (ML) some clay

hard, gray, silty fine sandy Clay(CL) few pebbles trace shale

135.3-136.6ft Shale, gray, very hard, clayey

Bottom of Hole-Elevation-452.5
-Depth-136.6ft

No gain or loss of water

Piezometer Installation:
4' of 2" PVC Blank Casing from 84' to 80'; 5' #80 screen from 80' to 75', 78.48' of 2" PVC Blank Casing from 75' to 3.48' above ground surface. Sand pack around casing from bottom of hole to 70', bentonite seal around casing at top of sand pack, annulus backfilled with grout to ground surface.

For Water Table information consult Section 4.1.3.

SOIL BORING NO. 40

BECHTEL Belle River

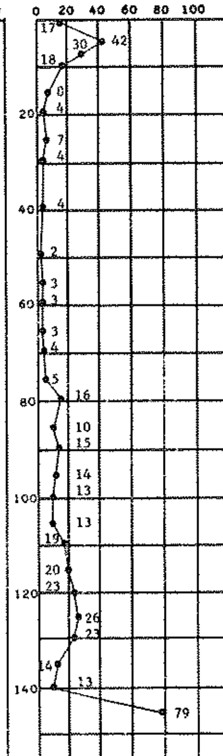
LOCATION: N 8,016 E 12,991   GROUND ELEVATION 600.2   DATE DRILLED: 11-19-73 11-21-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000 | MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80 | DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110 | OTHER LABORATORY TESTS | SAMPLE TYPE & NUMBER | NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 | % CORE RECOVERY | SYMBOL | DESCRIPTION

DEPTH IN FEET

NO UNDISTURBED SAMPLES TAKEN



% CORE RECOVERY: 20

DESCRIPTION

black sandy Topsoil
stiff, brown, silty Clay (CL) trace of fine sand
hard, some gray mottling
plastic to firm, gray, trace of sand, few pebbles
soft, gray, silty Clay (CL-CH)
plastic, dark gray, fine sandy silty Clay (CL) some pebbles
very soft, gray, silty Clay (CH)
plastic, gray, silty Clay (CL) some fine sand
—plastic, trace of sand, some pebbles
—plastic to firm, some fine sand
—soft to plastic
med. compact, gray, fine sandy Silt (ML) trace of clay
—stiff, gray, clayey Silt (ML) sand lenses, some pebbles
145.0-156.0ft Shale, black, soft, some thin laminae of sand

Bottom of Hole-Elevation-444.2
-Depth-156.0ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite slurry in soil and cement grout in rock.

SOIL BORING NO. 42

BECHTEL Belle River

DUNN 10-72*

LOCATION: N 7,004 E13,000

GROUND ELEVATION 600.5

DATE DRILLED: 11-20-73

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

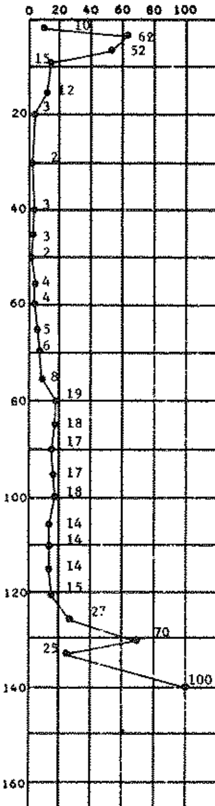
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100



% CORE RECOVERY: 90; 100

SYMBOL

DEPTH IN FEET: 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

DESCRIPTION

clayey & sandy Fill

stiff, brown silty Clay (CL) trace of sand

med. brown & gray silty Clay (CL)

soft, gray silty Clay (CH)

med. compact, gray clayey Silt (ML)

compact, gray Silt (ML) some sand

med. to firm gray sandy Clay (CL)

compact, gray clayey Silt (ML)

med. gray silty Clay (CL) some sand

hard, gray sandy Clay (CL) trace of shale (hardpan)

140.0-164.5ft Shale, black, decomposed & weathered, slightly micaceous crumbles easily

Bottom of Hole-Elevation-436.0
-Depth-164.5ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel in soil and cement grout in rock

SOIL BORING NO. 44

BECHTEL Belle River

LOCATION: N 5,344 E 12,319

GROUND ELEVATION 588.2

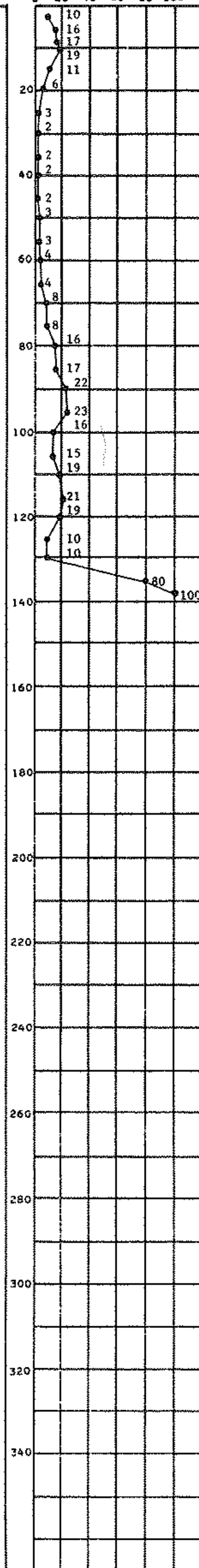
DATE DRILLED: 1-22-74 1-28-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

NO UNDISTURBED SAMPLES TAKEN

DEPTH IN FEET



% CORE RECOVERY: 30, 29, 100, 100

DESCRIPTION

Topsoil

firm, brown, silty Clay (CL), some gray mottling, trace fine sand

stiff

plastic, gray, some fine sand

very soft to soft, gray, silty Clay (CH)

plastic, gray, silty Clay (CL)some fine sand

firm, sandy, trace pebbles

plastic, some fine sand, few pebbles

firm, some pebbles

plastic, trace fine sand

hard, sandy, shaley, few pebbles

136.5-138.5ft Shale, gray, soft,
137.0-138.5ft brown, silty, fractured
138.5-147.0ft Mudstone, gray, soft, moist, fractured
147.0-165.0ft Shale, dark gray, firm, moist, highly fractured

Bottom of Hole-Elevation-423.2
-Depth-165.0ft

For Water Table information consult Section 4.1.3.

Water loss of 6-8 gal.

Hole backfilled with bentonite in soil and cement grout in rock

SOIL BORING NO. 46-A

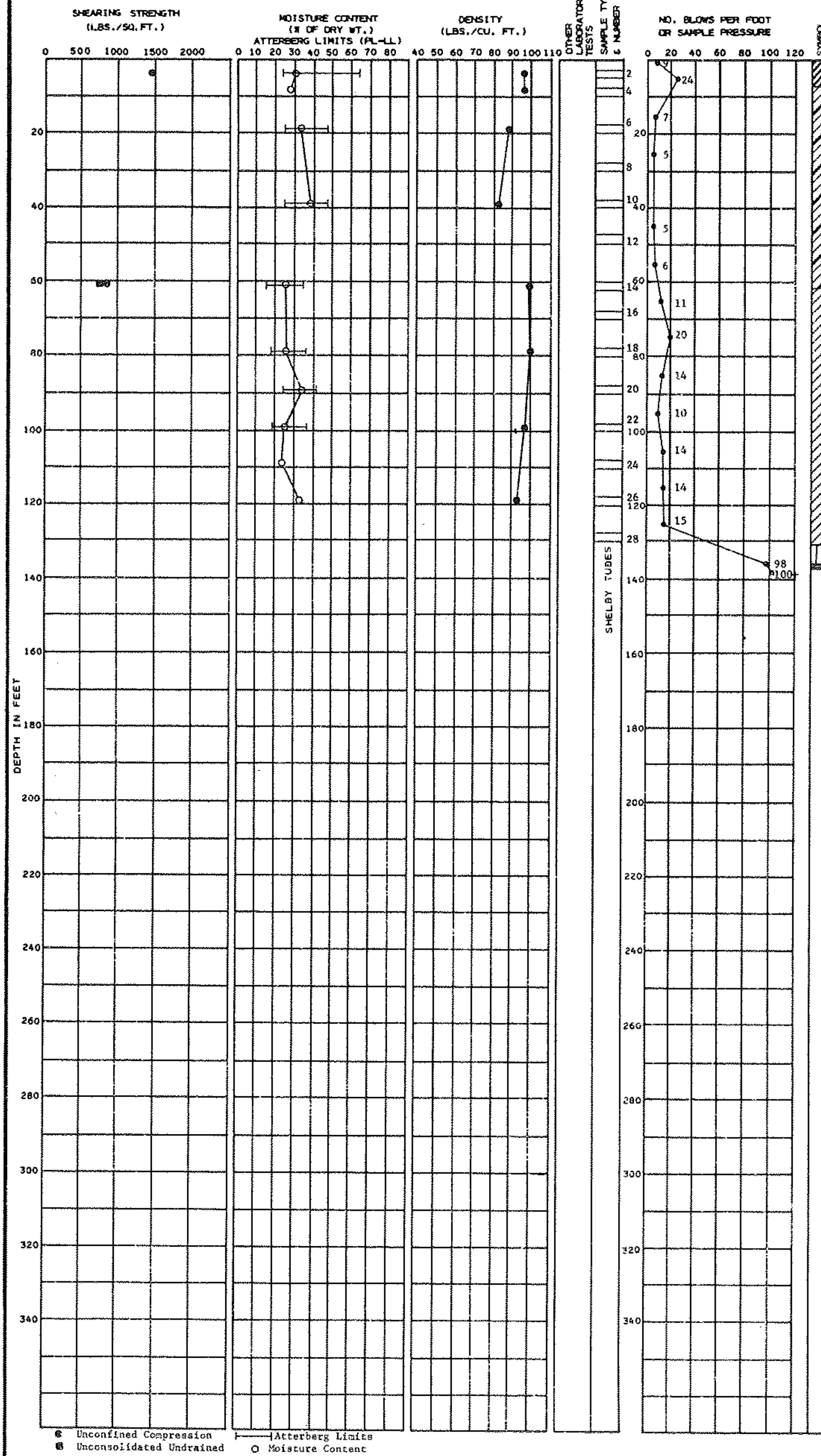
BECHTEL Belle River

LOCATION: N 3,950 E 12,584

GROUND ELEVATION: 587.5

DATE DRILLED: 1-14-74 1-23-74

SHEET 1 OF 1



DESCRIPTION

Stiff to very stiff, brown & gray, silty Clay (CH) trace sand, highly plastic

very stiff, brown, medium to high plasticity, silty Clay (CL-CH)

medium, gray, trace sand

soft to medium

soft, dark to very dark gray

Medium stiff, gray, silty Clay (CL) 35% coarse sand and fine gravel

firm, some fine sand

stiff, dark gray, little coarse sand and fine gravel

little fine sand, few pebbles

medium to stiff, little fine sand

soft to medium, dark gray, 20% fine to coarse sand and gravel

medium to stiff, gray, trace fine to coarse sand

fairly compact, gray, clayey Silt (ML), some fine sand

136.5-137.6ft Shale, gray, soft, clayey

Bottom of Hole-Elevation-449.9
-Depth-137.6ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and natural soil.

● Unconfined Compression
◙ Unconsolidated Undrained
├─┤ Atterberg Limits
○ Moisture Content

SOIL BORING NO. 48

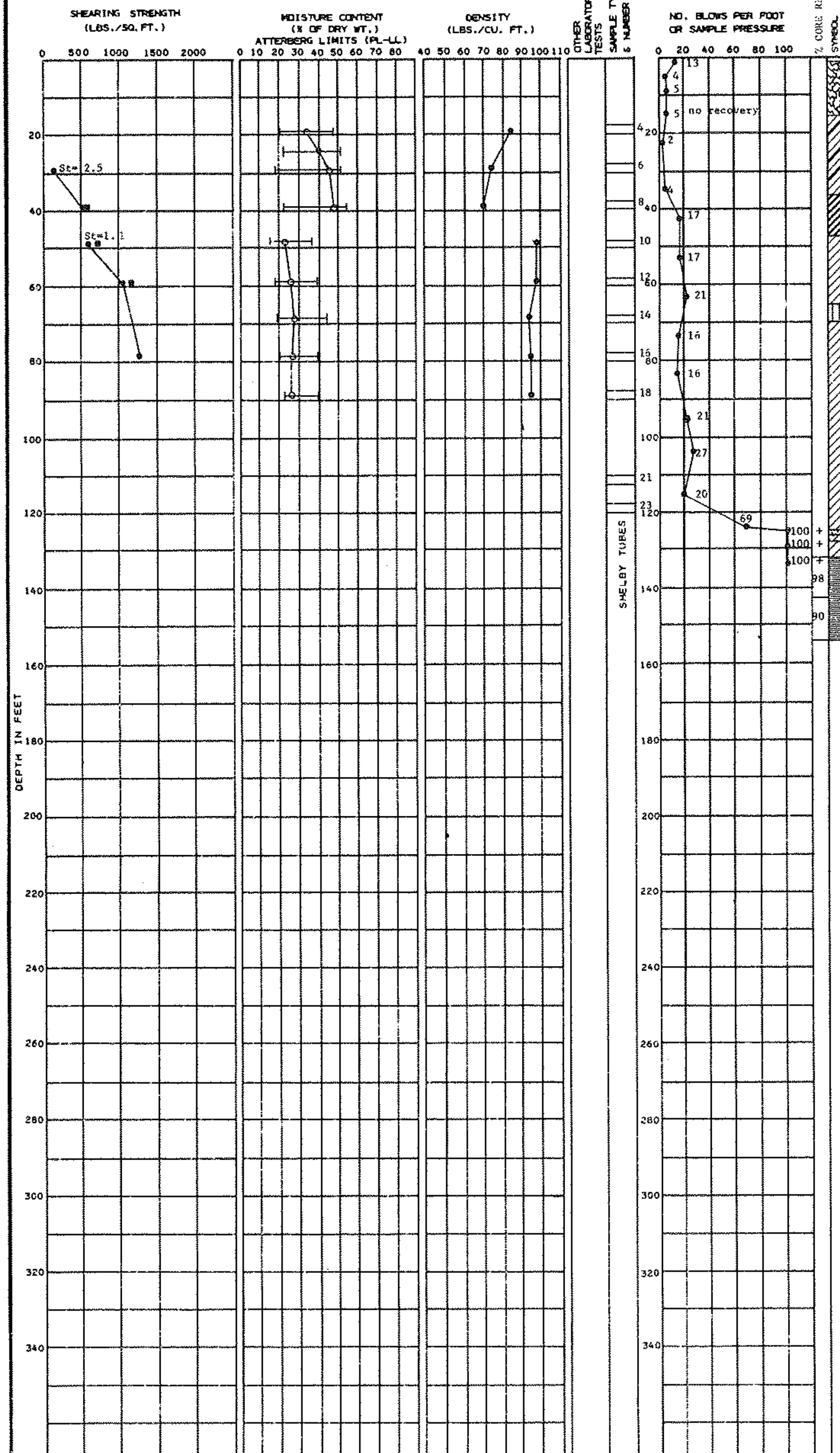
BECHTEL Belle River

LOCATION: N 2,951 E15,471

GROUND ELEVATION 581.8

DATE DRILLED: 12-19-73 1-8-74

SHEET 1 OF 1



DESCRIPTION

Depth	Description
	cinders, fly ash Fill
	loose, gray, limestone Fill, some sand
	very soft, gray, silty Clay (CL-CH) top 16-20' possibly disturbed — highly plastic
	firm, highly plastic, gray, silty Clay (CH) some sand, trace pebbles
	firm, moderately plastic, gray, sandy, silty Clay (CL) 20 to 25% fine to coarse sand and 10-15% fine gravel
	fairly compact, fine sandy Silt (ML)
	plastic, gray, silty Clay (CL) some fine sand, trace fine gravel
	— 10-15% fine to coarse sand and fine gravel
	— 20-25% fine to coarse sand and 10% fine gravel
	— firm, gray, some fine sand, trace pebbles
	— plastic, gray, trace fine sand
	— hard, gray, very sandy, few pebbles
	compact, very fine Sand(SP) some silt
	very hard, gray, clayey fine Sand(SC)
	very hard, gray, sandy Clay (CL) (hardpan)
	133.8-153.8ft Shale, gray, firm to soft, extremely fragmented and easily broken

Bottom of Hole-Elevation-428.05
-Depth-153.75ft

For Water Table information consult Section 4.1.3.

Water Level
At completion - 40.5'
Water Level
0800 33.5' 1-7-74

Bailed to 67.0'
1130 hours 67.91'
1400 " 66.33'
1600 " 66.08'
1800 " 65.25'
Water Level
0800 60.08' 1-8-74

Encountered gas at 98.0' while grouting casing at 98.0'. Extra precautions taken while grouting hole (slight pressure).

Hole backfilled with bentonite and natural soil in soil and cement grout in rock

● Unconfined
■ Unconsolidated Undrained
St = Sensitivity

○ Moisture Content
├─┤ Atterberg Limits

SOIL BORING NO. 50

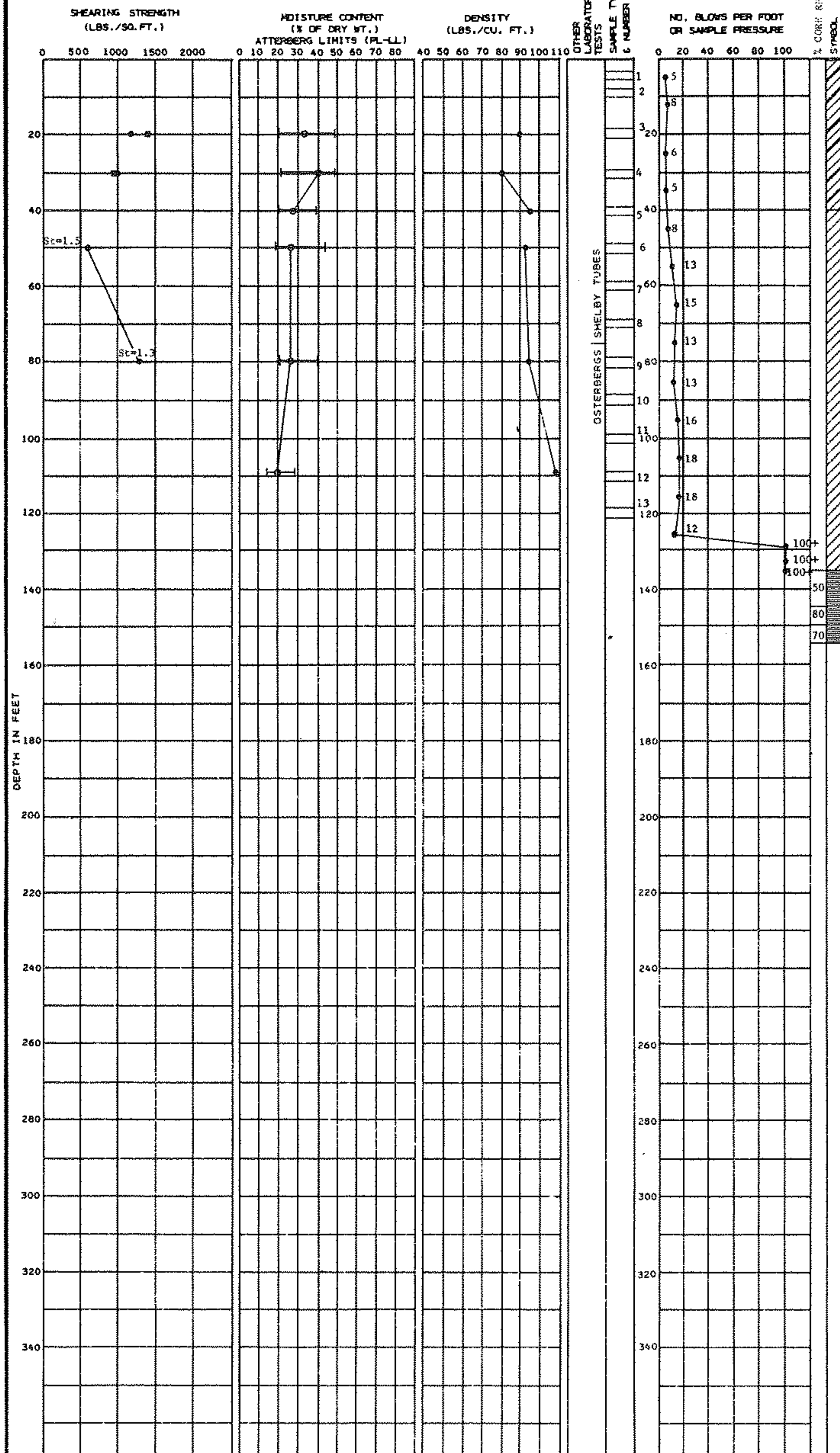
BECHTEL Belle River

LOCATION: N 2,052 E15,176

GROUND ELEVATION: 580.6

DATE DRILLED: 12-21-73 1-7-74

SHEET 1 OF 1



DESCRIPTION

cinder coal (fill)

medium, brown, silty Clay (CL-CH) (possible fill)

soft, brown, some peaty structure (possible fill or river sediments)

plastic, brown & gray

trace sand

plastic, gray, trace sand and pebbles

firm, moderately plastic, gray, silty Clay (CL) 20-30% fine to coarse sand and fine gravel

15-20% fine to coarse sand

15% fine to coarse sand and fine gravel

firm, gray, some fine sand, few pebbles

very hard, gray, some pebbles, seams of fine sand (Hardpan)

135.0-154.9 ft Shale, gray, silty, highly hackly fractured, breaks easily. 137.8-140.3 ft local dip approximatel 30°, firm. 146.5-150.0 ft local dip approximately 30°, firm

Bottom of Hole-Elevation-425.7
-Depth-154.9 ft

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and natural soil in soil and cement grout in rock.

● Unconfined
■ Unconsolidated Undrained
St = Sensitivity

○ Moisture content
├─┤ Atterberg limits

SOIL BORING NO. 53

BECHTEL Belle River

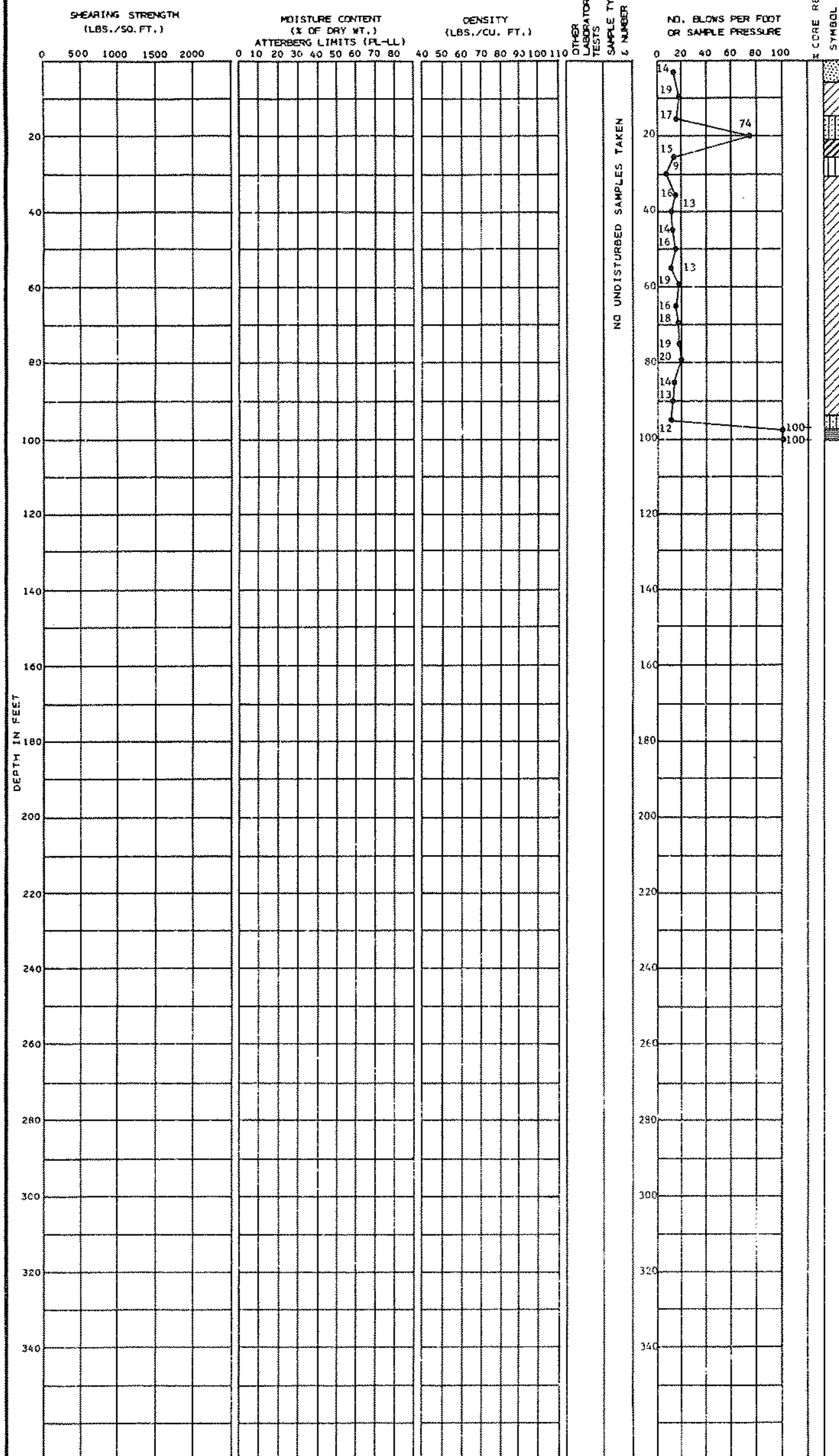
DUNN 10-73

LOCATION: N 2,645 E 15,506

GROUND ELEVATION 547.9

DATE DRILLED: 3-29-74

SHEET 1 OF 1



DESCRIPTION

medium compact, gray, medium to coarse Sand (SW) coal

firm, brownish gray, silty, sandy Clay (CL) coarse sand seams

very compact, gray Silty Sand (SM) fine

soft, gray, silty Clay (CH)

firm, gray, clayey Silt(ML)

medium, gray, silty Clay (CL) some sand and gravel

soft, trace sand and gravel

soft, reddish, silty, sandy clay some gravel

very compact, gray Silty Sand (SM) fine, trace shale

97.5-100.0ft Shale, gray, soft

Bottom of Hole-Elevation-447.9
-Depth-100.0ft

Note: Hole drilled from drilling platform in 30.9ft of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and soil

SOIL BORING NO. 55

BECHTEL Belle River

LOCATION: N 1,907 E 15,249

GROUND ELEVATION 543.3

DATE DRILLED: 3-20-74 3-26-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

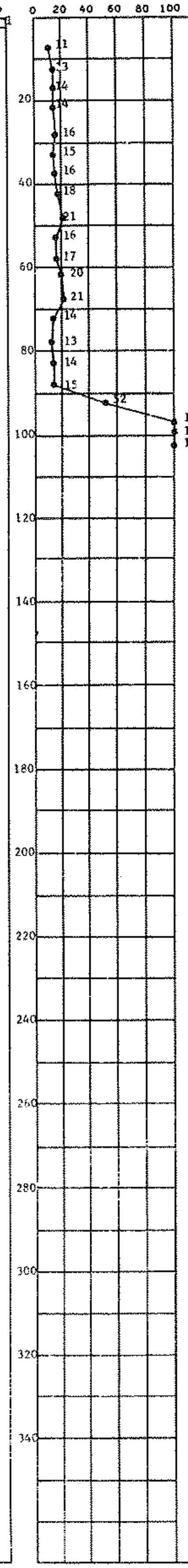
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER: OSTERBERG

DEPTH IN FEET

NO. BLOWS PER FOOT OR SAMPLE PRESSURE



% CORE RECOVERY: 46, 85, 90

SYMBOL

DESCRIPTION

loose, brown, fine to medium sand (SW) and gravel

soft, brownish gray, silty clay (CH) some sand and gravel

medium, gray, silty clay (CL) some sand and gravel

compact, gray, fine sand (SP)

medium, gray, silty clay (CL) little sand

compact, gray, layers of fine sand and clayey sand (SC)

very compact, gray, fine to coarse sand (SW) trace gravel

101.7-120.2 ft. shale, dark gray, soft, disintegrated, horizontal bedding in part, moist; fine to coarse, very gravelly & cobbles; firm from 119.9 to 120.2 ft.

Bottom of hole - Elevation - 428.1
- Depth - 120.2 ft.

NOTE: Hole drilled from drilling Platform in 30.7 ft. of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite in soil and cement in rock

SOIL BORING NO. 57

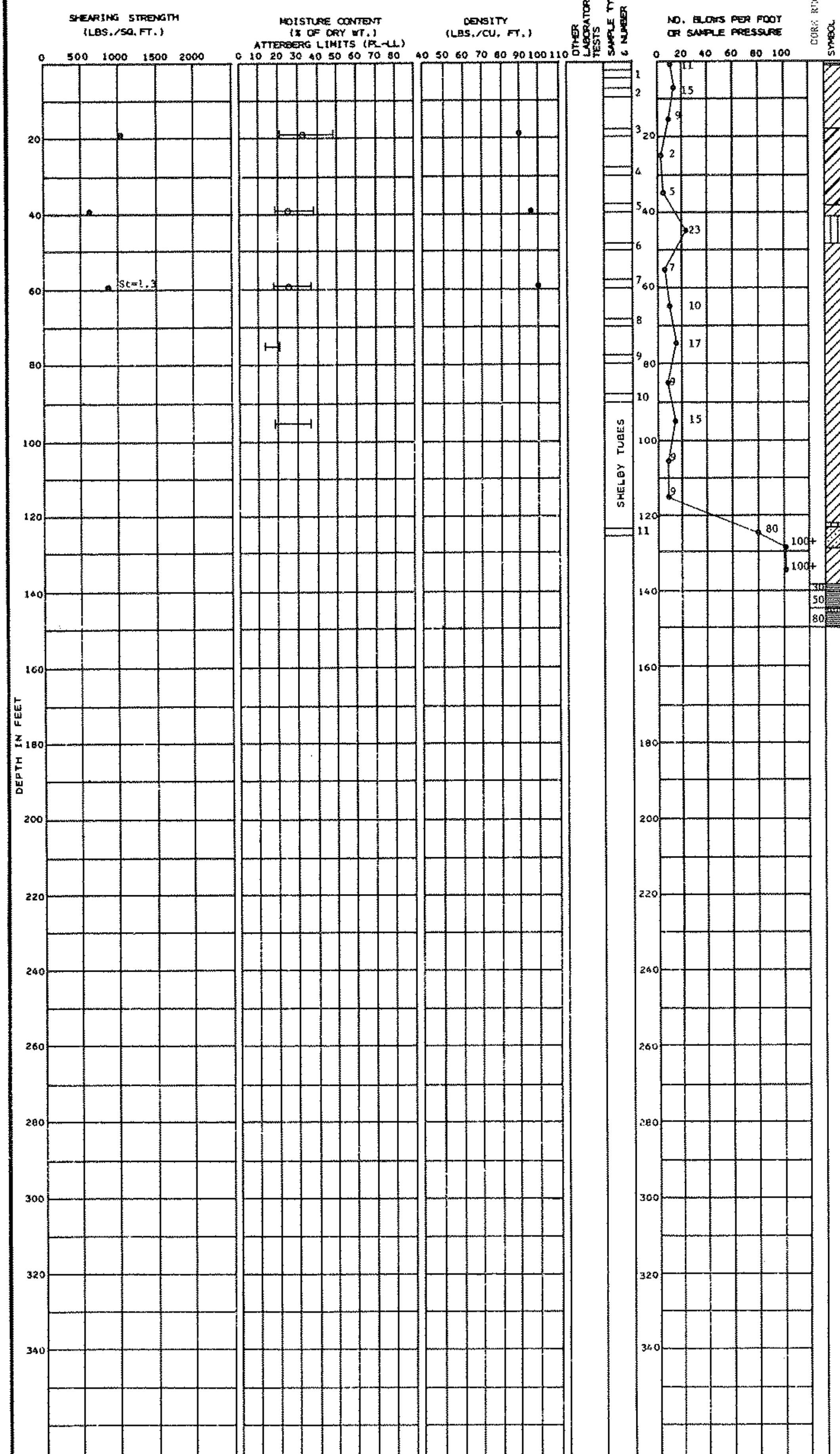
BECHTEL Belle River

LOCATION: N 2393 E15140

GROUND ELEVATION 582.3

DATE DRILLED: 1-10-74 1-16-74

SHEET 1 OF 1



DESCRIPTION

bottom ash Fill

loose, brown, fine Sand (SP)

plastic, brown & gray, silty Clay (CL) some sand

plastic to firm, brown, trace fine sand

soft, moderate to high plasticity, gray, silty Clay (CL-CH) trace fine sand

firm, moderate plasticity, gray, silty Clay (CL) 20-25% fine to coarse sand and fine gravel

compact, gray, fine sandy Silt (ML) trace clay

plastic, gray, silty Clay (CL) some fine sand

20-25% fine to coarse sand and fine gravel

plastic to firm, gray, sandy

trace pebbles

silty, trace fine sand

10% fine to coarse sand

compact, gray, very fine sandy Silt (ML)

compact, gray, very fine silty Sand (SC)

very compact, clayey, trace pebbles

very hard, gray, fine sandy silty Clay (CL) trace pebbles (hardpan)

138.0-140.5ft Mudstone, gray, moist, silty, highly weathered

140.5-145.0ft Shale, gray, moist, fractured

145.0-146.2ft Sandstone, moist, medium to fine grained, some shale

146.2-150.0ft Shale, gray, firm with seams of highly fractured shale

Bottom of Hole-Elevation-432.3
-Depth-150.0ft

For Water Table information consult Section 4.1.3.

Slight indication of gas at 124.5'. Water bubbling in casing.

Hole backfilled with Bentonite and Natural Soil in soil and Cement Grout in rock

● Unconfined
St = Sensitivity

o Moisture Content
├─┤ Atterberg Limits

SOIL BORING NO. 59

BECHTEL Belle River

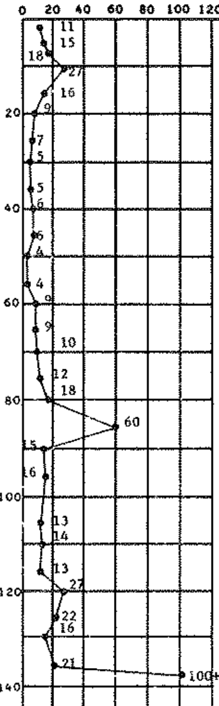
LOCATION: N 5,283 E 14,042 GROUND ELEVATION 593.1

DATE DRILLED: 1-23-74 1-29-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

fill, cinders, clay, etc.

firm to stiff, brown, silty Clay (CL) trace fine sand

—plastic, gray

soft, gray silty Clay (CH)

plastic, gray silty Clay (CL) trace fine sand, few pebbles

—firm, sandy silty Clay (CL) few pebbles

—stiff, fine sandy silty

—plastic, silty Clay (CL), some fine sand

fairly compact, gray, clayey Silt (ML) trace Shale, pebbles

135.0-136.0ft Shale, gray, soft, weathered with sand seams

Bottom of Hole-Elevation-457.1
-Depth-136.0ft

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and natural soil.

SOIL BORING NO. 63

BECHTEL Belle River

LOCATION:* N 9,208.32 E 9,376.12

GROUND ELEVATION 587.6

DATE DRILLED: 2-28-74 3-7-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

Sample numbers: 2, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21; OSTERBERGS

No. blows per foot: 9, 2, 2, 2, 3, 10, 14, 28, 33, 12, 38, 39, 35, 35, 38, 38, 36, 38, 100+

% Core recovery: 100, 100

DESCRIPTION

sandy topsoil

plastic, brown, sandy clay (CL)
firm to stiff, silty clay, some fine sand
plastic, gray, trace fine sand

very soft to soft, gray, silty clay (CH)

Lost approximately 25 gallons of water between 55.0 - 70.5 ft.

plastic to firm, gray, silty clay (CL) some fine sand
— stiff, same, few pebbles

— soft to plastic

medium compact, gray sand (SP) fine

compact, gray sand (SW) very fine to medium, few pebbles

medium compact, gray silt (ML) some fine sand

143.5-166.5 ft. shale, gray
143.5-145.5 ft. soft, trace of clay and pebbles
145.5-156.5 ft. soft, highly fractured
155.5-166.5 ft. interbedded light and dark gray, firm, horizontal bedding, locally contorted, abundant quartz viens

Bottom of hole - Elevation - 421.2
- Depth - 166.5 ft.

*BENCH MARK ØBR - 3
16.5' of cement grout from 166.5' to 150.0'; 150.0' of 2" PVC blank casing from 150.0' to surface; casing cemented to surface and bench mark plate placed on top.
Benchmark Elev - 588.0

For Water Table information consult Section 4.1.3.

SOIL BORING NO. 65

BECHTEL Belle River

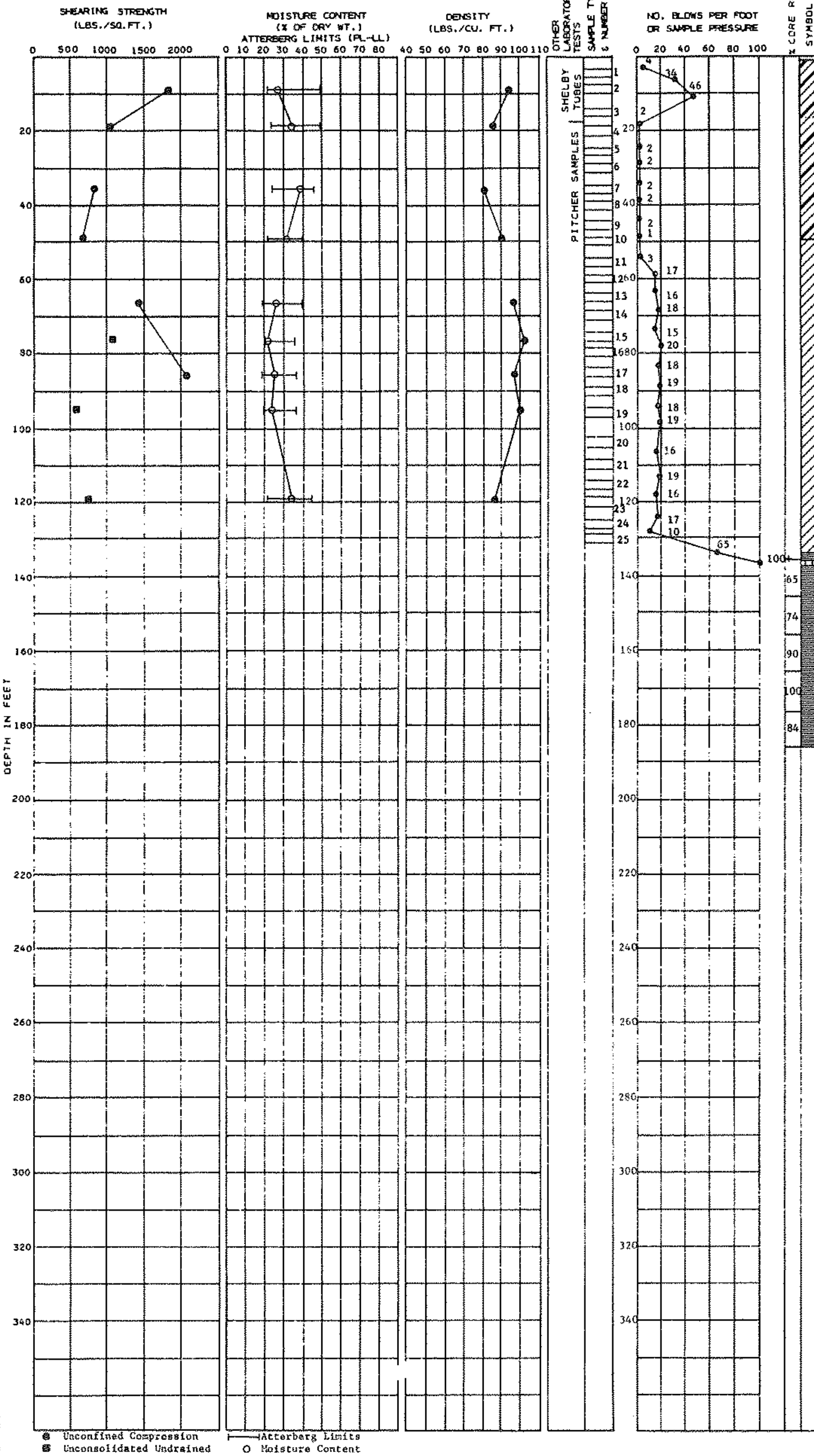
DUNN 19-72*

LOCATION: N 3,800 E 12,060

GROUND ELEVATION 586.0

DATE DRILLED: 2-12-74 2-26-74

SHEET 1 OF 1



DESCRIPTION

- black, clayey topsoil
- soft, brown, silty Clay (CL-CH)
- very stiff, 5% gravel
- firm, gray

Firm, dark gray, silty Clay (CL) 20% fine to coarse sand
- plastic, trace to some fine sand
- small seam black silty sand, some gravel
- stiff, 30% fine to coarse sand and fine gravel
- dark gray
- 30% fine to coarse sand and fine gravel
- firm, dark gray, 15% coarse sand and fine gravel
- firm to stiff, gray, 10% fine to coarse sand and fine gravel
- soft to plastic, trace fine sand
- firm, some fine sand

134.0-136.8ft Shale, gray, soft, with some silt and sand seams

136.8-137.9ft Silt (ML), light gray

137.9-186.0ft Shale, dark gray, very soft to moderately soft, horizontal bedding. 137.9-176.0ft disintegrated to highly fractured. 150.0-152.7ft bedding dips 5°

176.0-186.0ft moderately hard

Bottom of Hole-Elevation-399.9 -Depth-186.0ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with QUIK-GEL and natural soil in soil and cement grout in rock.

SOIL BORING NO. 101

BECHTEL Belle River

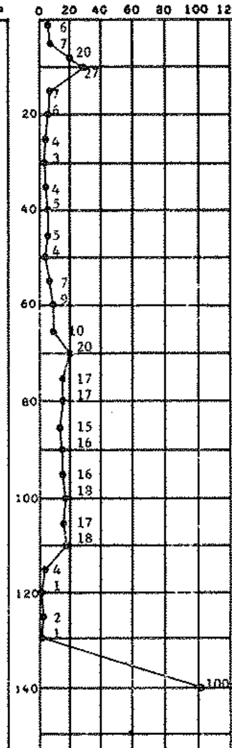
LOCATION: N 4,435 E 12,350 GROUND ELEVATION 589.7

DATE DRILLED: 2-5-74 2-7-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN			

DEPTH IN FEET



DESCRIPTION

clay, wood, cinders, fill

plastic to firm, brown, silty Clay (CL) some gray pockets, trace fine sand

firm

plastic, gray

very soft to soft, gray, silty Clay (CH)

plastic, gray, silty Clay (CL) trace fine sand, few pebbles

soft

compact, gray, silty Sand (SM) with some gravel

139.0-141.0ft Shale, gray, soft

Bottom of Hole-Elevation-448.7
-Depth-141.0ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil.

SOIL BORING NO. 103

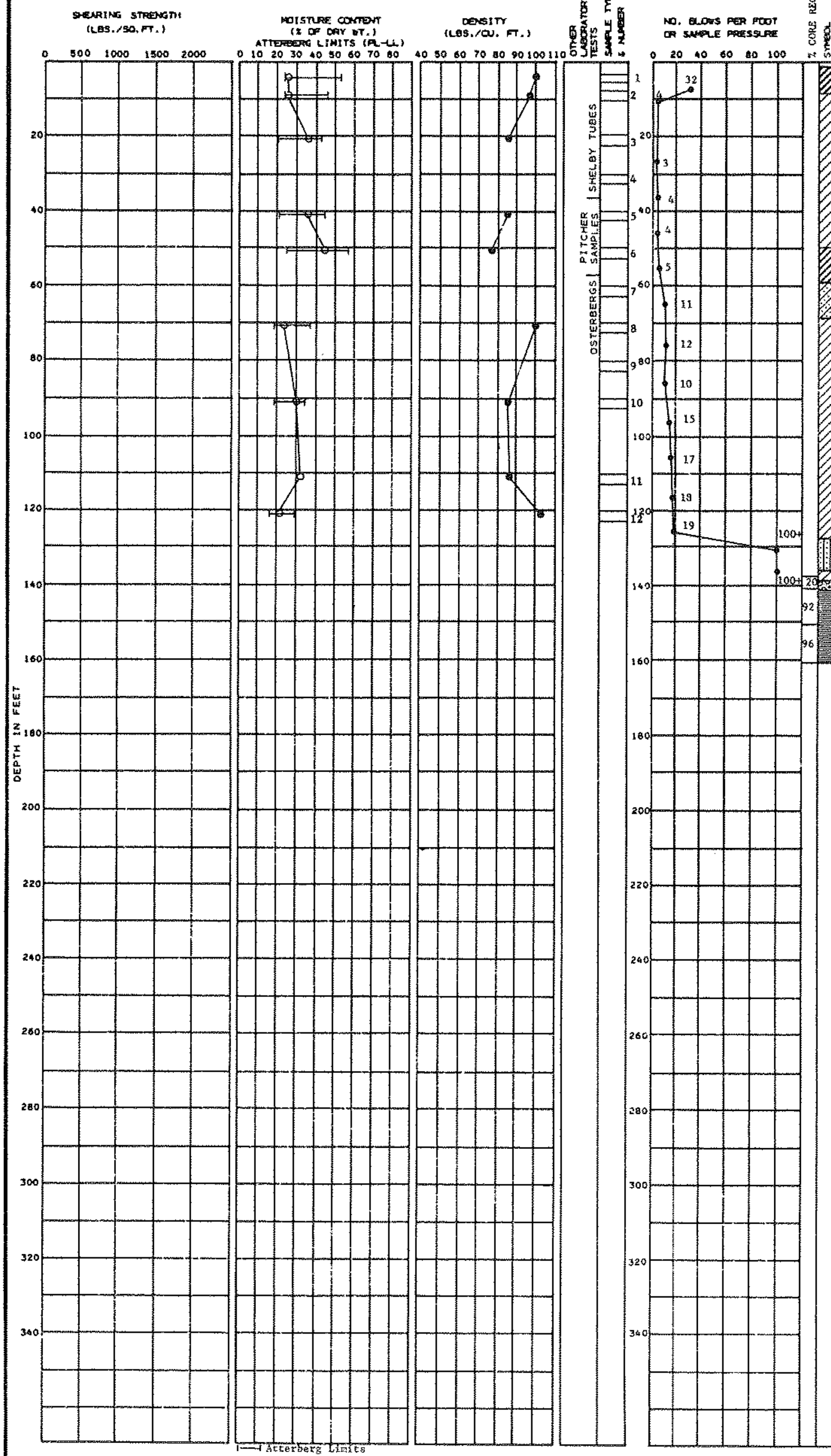
BECHTEL Belle River

LOCATION: N 5,000 E 11,000

GROUND ELEVATION: 588.3

DATE DRILLED: 2-26-74 3-5-74

SHEET 1 OF 1



DESCRIPTION

Black clayey topsoil

Plastic, brown, sandy, gravelly clay (CH)

very stiff to hard, silty clay, some fine sand, 5% gravel

Very stiff, olive brown & grayish brown, silty Clay (CL) 5% gravel

medium, gray, 5% fine to coarse sand

medium, gray brown, 5% fine to coarse sand

Medium, gray, silty Clay (CH) highly plastic

Medium, gray, clayey sand (SC), trace gravel

Stiff, gray, silty Clay (CL) 20% fine to coarse sand and fine gravel

soft, gray, 10% fine to coarse sand

15% fine to coarse sand

medium, dark gray, sandy, 35% fine to coarse sand

Compact, gray, fine silty sand (SM) trace pebbles

Hard, gray, silty clay (CL), some sand and shale chips

138.6-141.0 ft gravel (GP), dark gray shale and granitic cobbles

141.0-160.3 ft. shale, dark gray, soft to firm

141.0-150.3 ft. disintegrated to fractured

150.3-160.3 - fractured to intact

Bottom of hole - Elevation - 428.0
- Depth - 160.3 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with quik-gel and natural soil in soil and cement in rock

SOIL BORING NO. 105

BECHTEL Belle River

LOCATION: S 6,450 E 13,140

GROUND ELEVATION 600.7

DATE DRILLED: 2-26-74 3-6-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

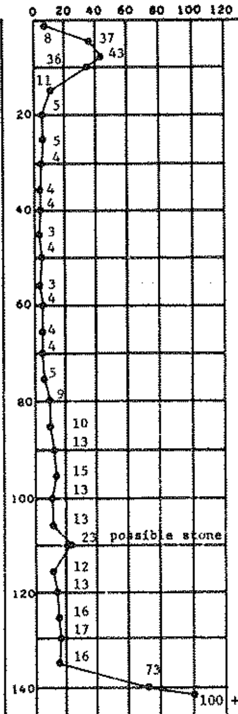
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120



SYMBOL

DEPTH IN FEET

DESCRIPTION

sandy topsoil

medium compact, brown, very fine to medium Sand (SW)

firm, brown, sandy Clay (CL)

stiff, silty clay, some fine sand with gray mottling

plastic, gray, trace very fine sand

soft, gray, silty Clay (CH) slight trace very fine sand

plastic, gray, silty Clay (CL) some very fine sand

plastic to firm, some fine sand

1.5' boulder

compact, gray, very fine Sand and Silt (SM)

142.0 - 142.67ft Shale, soft, gray, broken

Bottom of Hole-Elevation-458.03
-Depth-142.67ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil.

SOIL BORING NO. 109

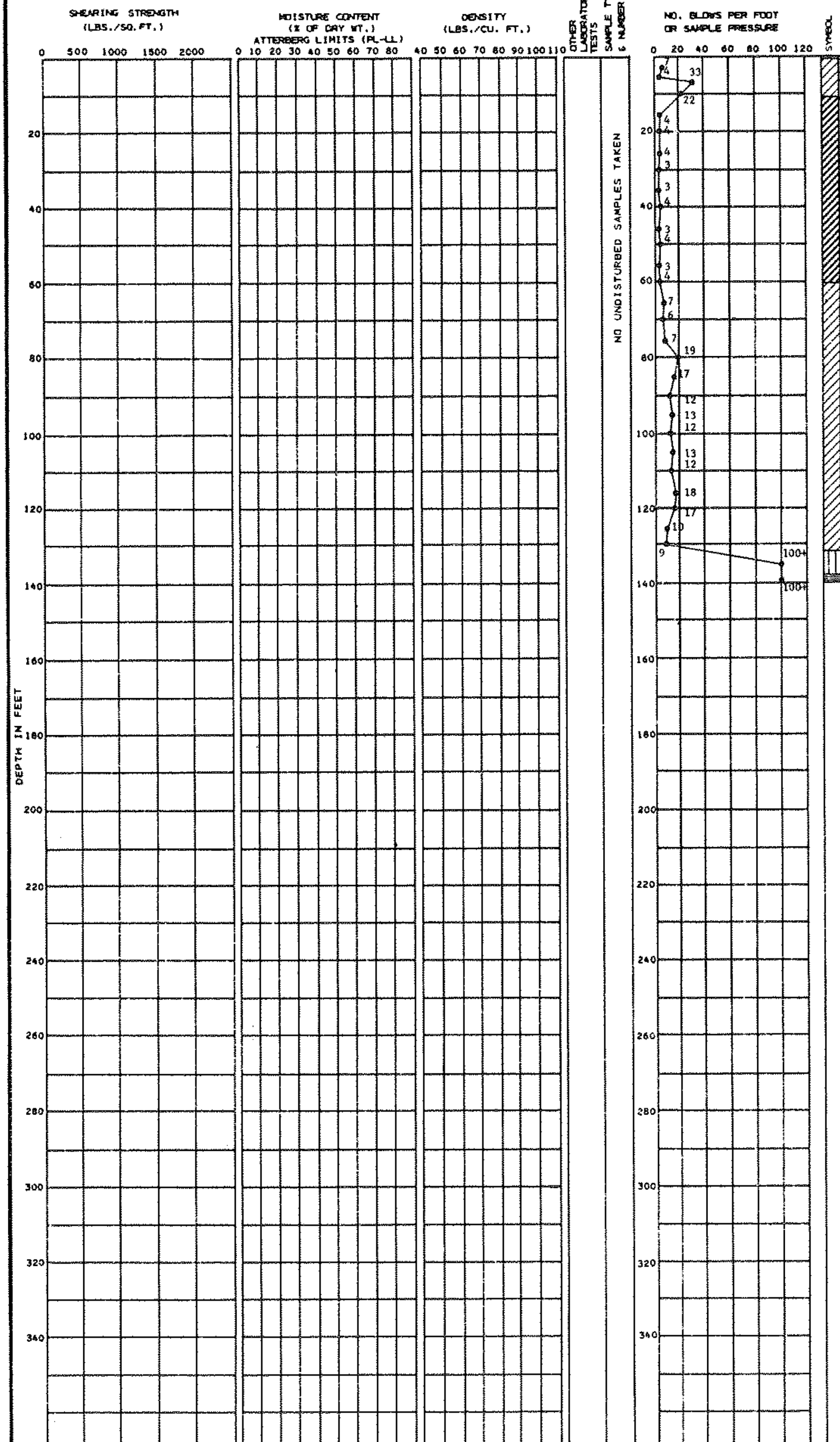
BECHTEL Belle River

LOCATION: N 6,600 E 11,000

GROUND ELEVATION 588.5

DATE DRILLED: 2-21-74 2-26-74

SHEET 1 OF 1



DESCRIPTION

Cinders, fill

Plastic, brown & gray, silty clay (CL)

Firm, some fine sand

Stiff

Very soft to soft, gray, silty clay (CH)

Plastic, gray, silty clay (CL), some fine sand

Firm, few pebbles

Plastic to firm

Soft to plastic

Compact, gray silt (ML), some clay & very fine sand

138.0-140.0 ft shale, gray, soft

Bottom of hole - Elevation - 438.5
Depth - 140.0 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil

SOIL BORING NO. 111

BECHTEL Belle River

LOCATION: N 6,800 E 9,360

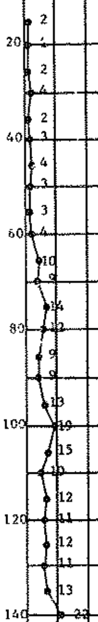
GROUND ELEVATION: 587.4

DATE DRILLED: 2-27-74 3-5-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

Sample type and number: 1, 2, 3; SHELBY TUBES



% Core Recovery: 78, 30, 60

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

DESCRIPTION

- cinders, fill
- peaty topsoil
- firm to stiff, brown and gray mottling, silty clay (CL) some fine sand
- firm, gray
- very soft to soft, gray, silty clay (CH)
- plastic, gray, silty clay (CL) some fine sand
  - plastic to firm
  - plastic, trace fine sand
- medium compact, gray silt (ML) trace clay
- stiff, gray, silty clay (CL) with sand and shale chips
- 145.0-164.3 ft. Shale, gray to dark gray, soft to moderately soft
  - 145.0-149.3 ft. fragmented
  - 149.3-153.0 ft. fractured
  - 153.0-164.3 ft. fragmented to fractured

Bottom of hole - Elevation - 423.15
- Depth - 164.25 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil in soil and cement grout in rock

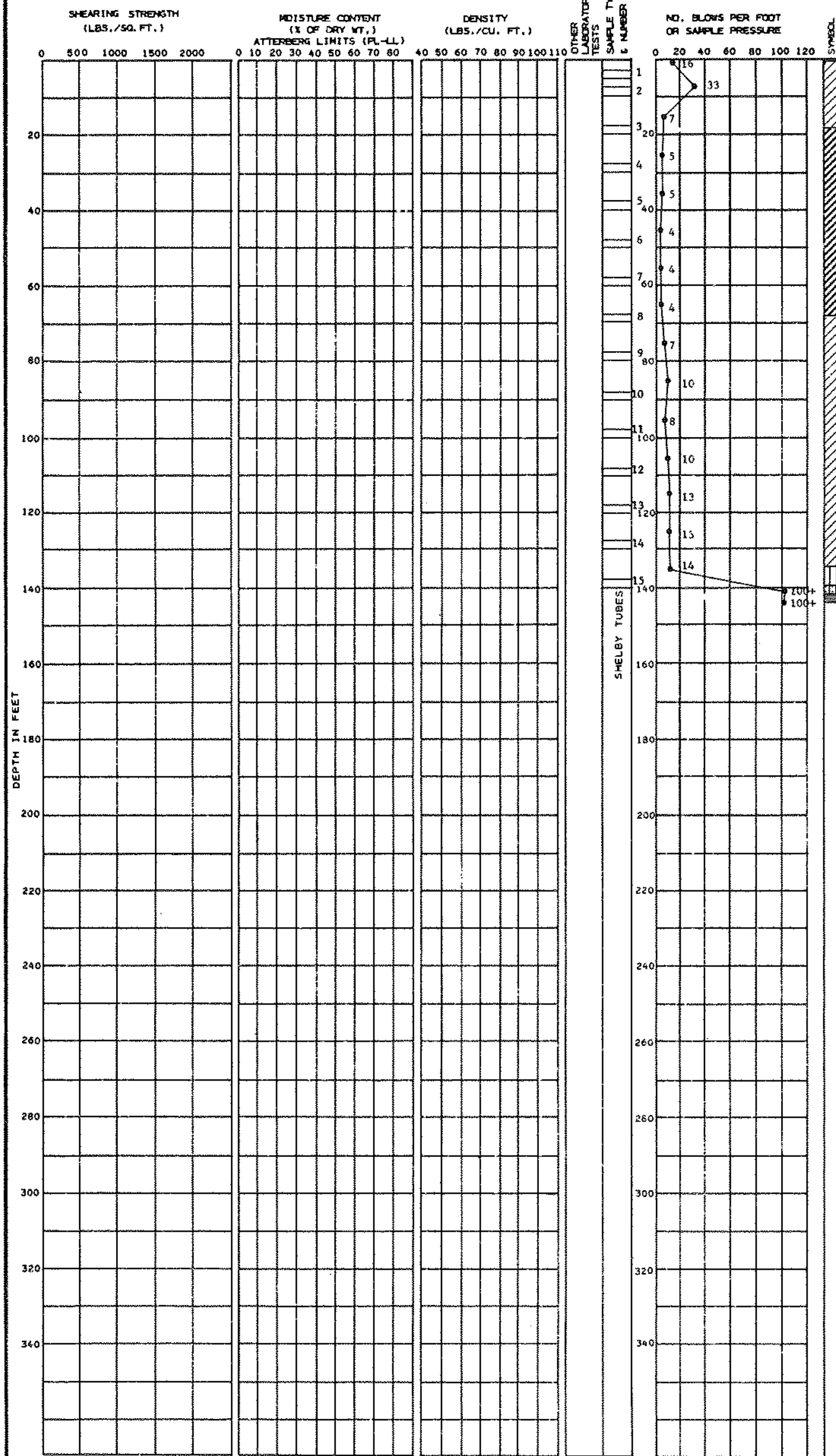
SOIL BORING NO. 113

BECHTEL Belle River

LOCATION: N 7,100 E13,060 GROUND ELEVATION 600.7

DATE DRILLED: 1-30-74 2-6-74

SHEET 1 OF 1



DESCRIPTION

sandy topsoil
stiff, brown, Clay (CL)
stiff, gray, silty sandy
soft, trace fine sand

very soft to soft, gray, silty Clay(CH)

plastic, gray, silty Clay (CL) some fine sand

compact, gray Silt (ML)

compact, gray, silty, very fine Sand (SM)

142.0-144.0ft Shale, gray, soft

Bottom of Hole-Elevation-456.7
-Depth-144.0ft

For Water Table information consult Section 4.1.3.

No Gain or Loss of Water

Hole Backfilled With Quick-Gel and Natural Soil

SOIL BORING NO. 115

BECHTEL Belle River

LOCATION: N 7,270 E 9,360 GROUND ELEVATION 585.5

DATE DRILLED: 2-5-74 2-12-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

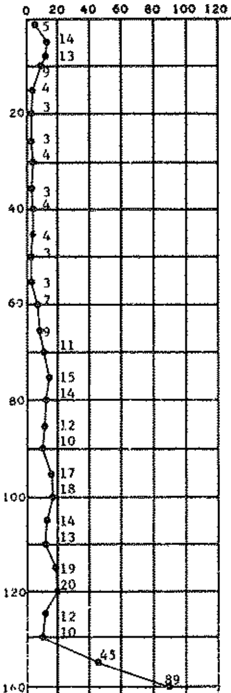
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER: NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120

DEPTH IN FEET 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340



SYMBOL

DESCRIPTION

clay, ash, gravel fill

stiff, brown, silty Clay (CL) some fine sand

firm, brown & gray, trace fine sand

plastic, gray, trace very fine sand

very soft to soft, gray, silty Clay (CH)

plastic, gray, silty Clay (CL) some fine sand

—firm

—plastic, trace fine sand

Sand (SP)

137.0-140.0ft Shale, gray, soft, interbedded with hard gray clay

Bottom of Hole-Elevation-445.5 -Depth-140.0ft

For Water Table information consult Section 4.1.3.

No Gain or Loss of Water

Hole Backfilled With Quick-Gel and Natural Soil

SOIL BORING NO. 117

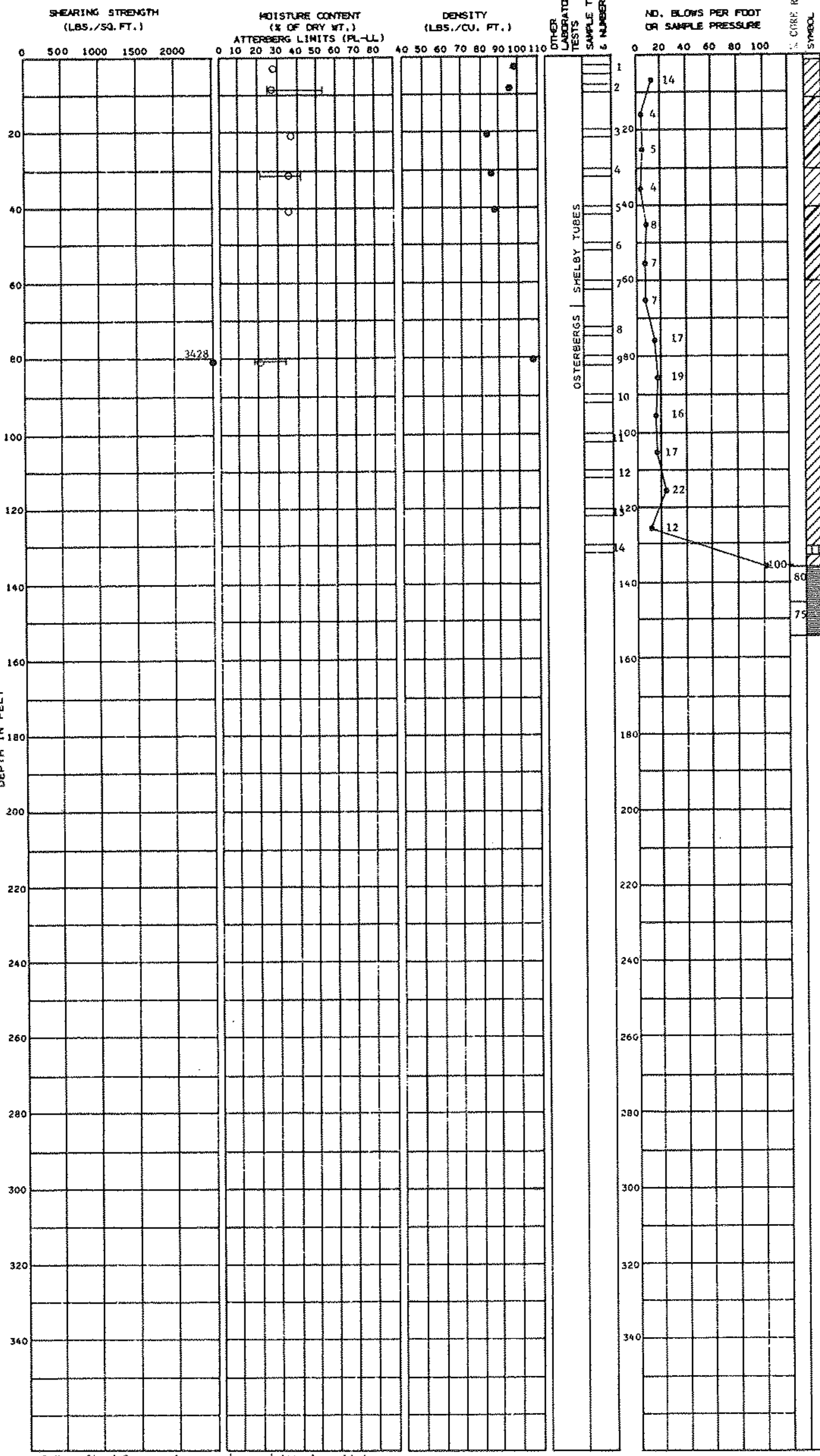
BECHTEL Belle River

DUNN (6-73)

LOCATION: N 7,510 E11,300 GROUND ELEVATION 588.8

DATE DRILLED: 1-29-74 2-5-74

SHEET 1 OF 1



DESCRIPTION

- black, clayey, topsoil & cinder fill
- stiff to very stiff, dark grayish brown mottled light olive brown, silty Clay (CL) trace sand
- very stiff, 10% coarse sand and fine gravel
- firm, dark gray, silty Clay (CL-CH) 5-10% coarse sand
- soft to firm, very dark grayish brown, silty Clay (CL) 5% coarse sand and gravel
- soft to firm, dark grayish brown, highly plastic, silty Clay (CH-CL)
- plastic to firm, gray, silty Clay (CL) some fine sand
- stiff, grayish brown, sandy, 25% fine to coarse sand and gravel
- slight trace of sand
- compact, gray, very fine sandy Silt (ML)
- stiff, gray, silty Clay (CL) some very fine sand
- 136.5-154.0ft Shale, dark gray. 136.5-139.0ft light gray, horizontal and contorted bedding

Bottom of Hole-Elevation-434.8
-Depth-154.0ft

No Gain or Loss of Water

For Water Table information consult Section 4.1.3.

Hole Backfilled With Bentonite and Natural Soil in Soil and Cement Grout in Rock

● Unconfined Compression
├──┤ Atterberg Limits
○ Moisture Content

SOIL BORING NO. 119

BECHTEL Belle River

LOCATION: N 7,660 E 10,630

GROUND ELEVATION 587.9

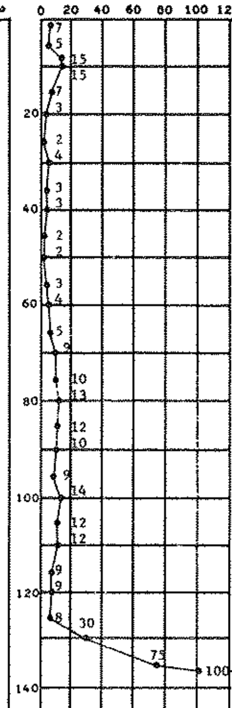
DATE DRILLED: 2-14-74 2-19-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) | MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) | DENSITY (LBS./CU. FT.) | OTHER LABORATORY TESTS | SAMPLE TYPE & NUMBER | NO. BLOWS PER FOOT OR SAMPLE PRESSURE | SYMBOL | DESCRIPTION

DEPTH IN FEET

NO UNDISTURBED SAMPLES TAKEN



DESCRIPTION

- sandy topsoil
- medium compact, brown, fine Sand (SP)
- plastic, gray, silty Clay (CL) some fine sand
- very soft to soft, gray, silty Clay (CH)
- plastic, gray, silty Clay (CL) trace fine sand
- medium compact, gray, clayey Silt (ML) trace fine sand
- hard, gray, sandy Clay (CL) some pebbles
- 135.0-135.5ft Shale, gray, soft

Bottom of Hole-Elevation-452.4
-Depth-135.5ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with quik-gel and natural soil

SOIL BORING NO. 121

BECHTEL Belle River

LOCATION: N 8,017 E 4,999

GROUND ELEVATION 588.9

DATE DRILLED: 3-25-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.) 0 500 1000 1500 2000

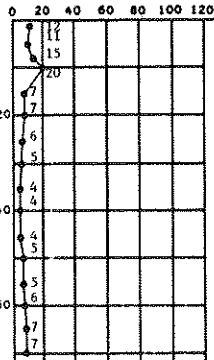
MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER: NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120



SYMBOL

DEPTH IN FEET: 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

DESCRIPTION

Gray, silty topsoil

Medium, mottled brown & gray, silty sandy clay (CL), trace of pebbles

Soft, gray, silty clay (CH), trace of sand

Bottom of hole - Elevation - 518.9
- Depth - 70.0 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil

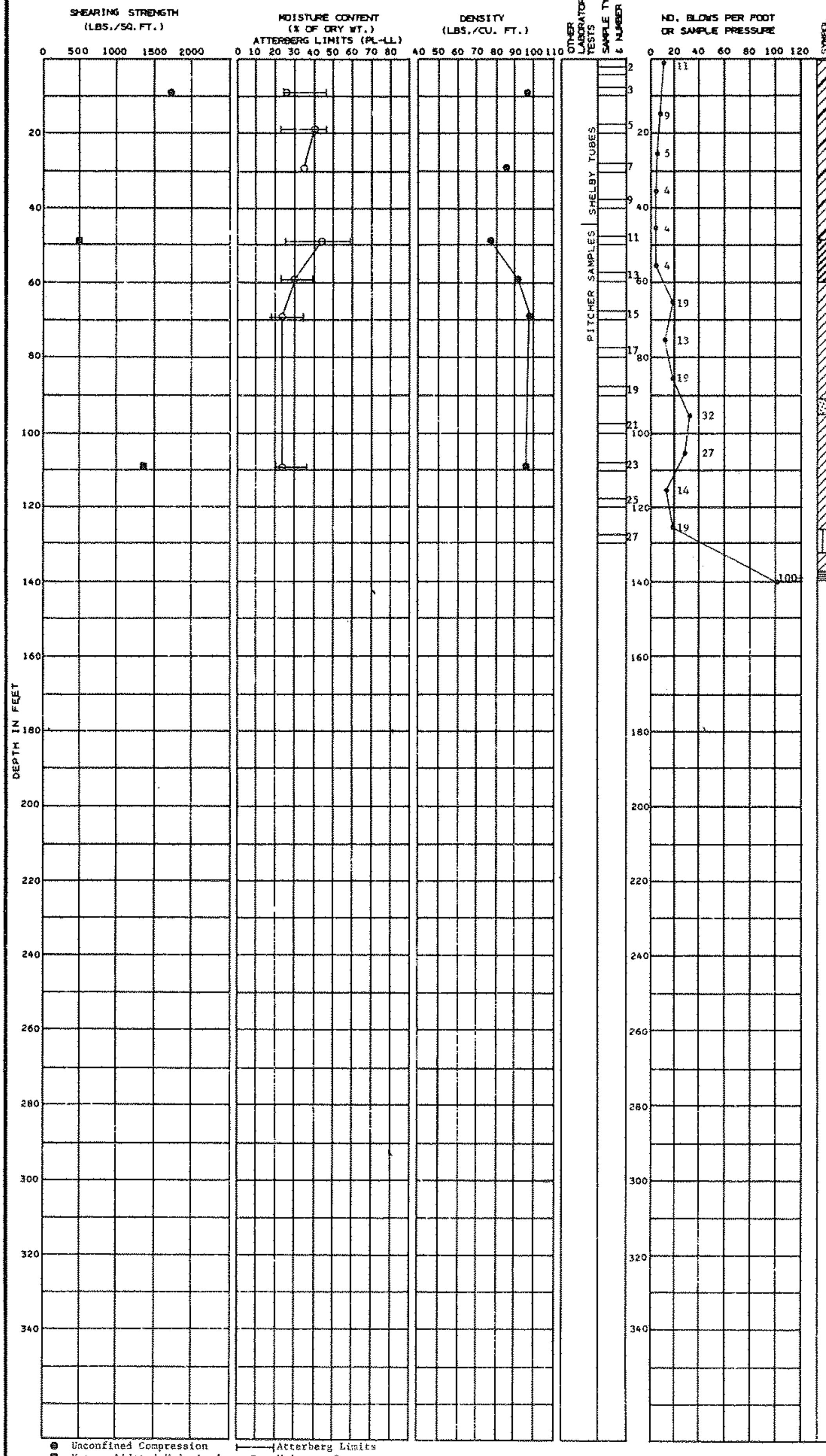
SOIL BORING NO. 123

BECHTEL Belle River

LOCATION: N 7,950 E 11,140 GROUND ELEVATION 588.8

DATE DRILLED: 2-1-74 2-6-74

SHEET 1 OF 1



DESCRIPTION

- sandy topsoil
- Very stiff, olive brown, silty Clay (CL-CH) some fine sand, trace gravel
  - stiff
  - very soft to soft, grayish brown
  - soft, grayish brown
  - soft, dark grayish brown, 5% fine to coarse sand
- Firm, gray, silty Clay (CH) 10% fine gravel and coarse sand
- Firm, gray, silty Clay (CL) 10% fine to coarse sand, few layers / lenses silty clay, 40% fine to medium sand
  - firm to stiff, dark gray, 15% fine to coarse sand and fine gravel
- compact, gray Sand (SP) trace gravel
- plastic to firm, gray, silty Clay (CL) trace fine sand
  - firm to stiff, dark gray, 20% fine to coarse sand and fine gravel
- loose, gray, clayey Silt (ML) trace fine sand
- hard, gray, sandy Clay (CL) few pebbles (hardpan)
- 137.0-140.0ft Shale, gray, soft

Bottom of Hole-Elevation-448.8ft
-Depth-140.0ft

For Water Table information consult Section 4.1.3.

No Gain or Loss of Water

Hole Backfilled With Quick-Gel and Natural Soil

SOIL BORING NO. 126

BECHTEL Belle River

LOCATION: N 3,000 E 11,000

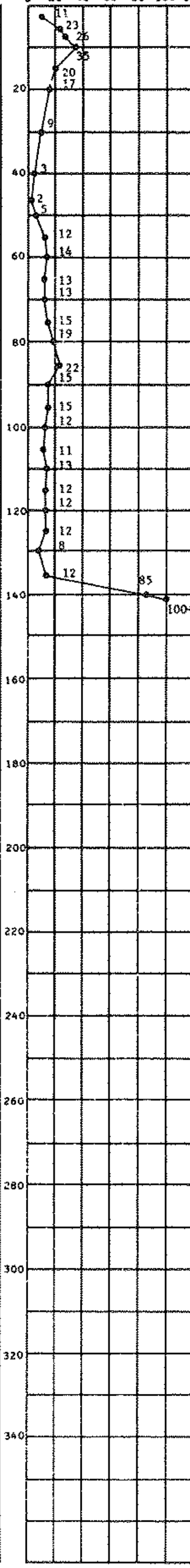
GROUND ELEVATION: 589.5

DATE DRILLED: 2-7-74 2-13-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110		NO UNDISTURBED SAMPLES TAKEN	0 20 40 60 80 100 120		

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

Sandy topsoil

Firm, brown, silty, clay fill, bricks cinders

Stiff, brown silty clay (CL) with some organic pockets

Very stiff, some fine sand

Firm, some gray mottling

Soft, gray, silty clay (CH)

Plastic, gray, silty clay (CL), some fine sand

Soft, trace of fine sand

Compact, gray silt (ML) with fine sand, trace of clay

Hard, gray, sandy clay (CL), few pebbles (hardpan)

141.0-141.5 ft. shale, gray, soft

Bottom of hole - Elevation -448.0
- Depth-141.5 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil

SOIL BORING NO. 128

BECHTEL Belle River

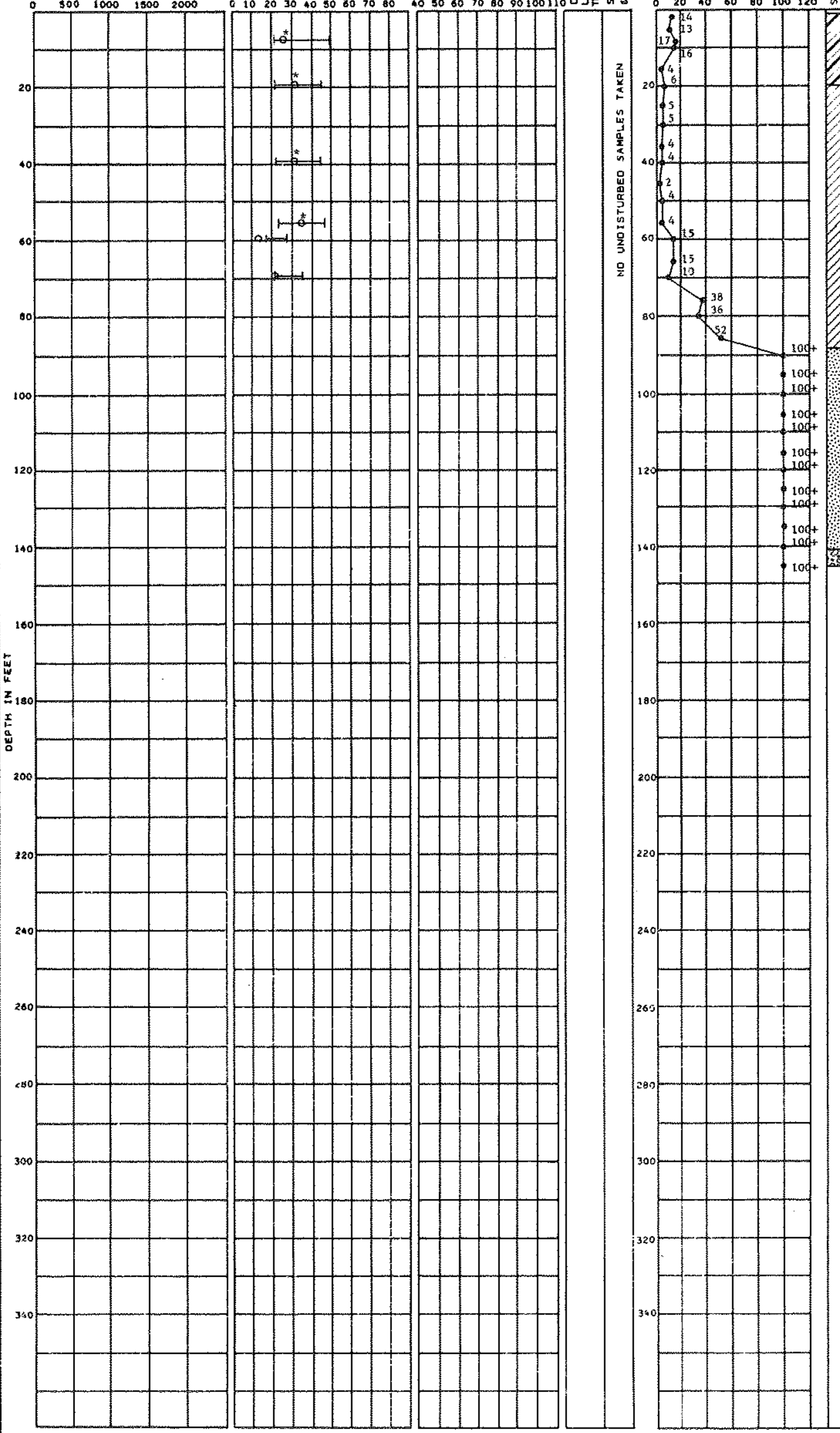
LOCATION: N 9,014 E 4,993

GROUND ELEVATION 595.3

DATE DRILLED: 3-26-74 3-28-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) | MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) | DENSITY (LBS./CU. FT.) | OTHER LABORATORY TESTS | SAMPLE TYPE & NUMBER | NO. BLOWS PER FOOT OR SAMPLE PRESSURE | SYMBOL | DESCRIPTION



DESCRIPTION

gray, clayey topsoil

medium to stiff, brown, silty Clay (CL-CH) some sand and gravel

grayish brown, highly plastic

medium, gray, no sand or gravel

medium, moderate to high plasticity, grayish brown, silty Clay (CL)

low plasticity, dark gray, 25% fine to medium sand

15% fine to medium sand, low to medium plasticity

very compact, gray, fine to coarse Sand (SW) some gravel

very compact, gray, sands and fine to medium Gravel (GW) fragments of shale

Bottom of Hole-Elevation-450.3
-Depth-145.0ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and soil

o Water Content
├─┤ Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 130

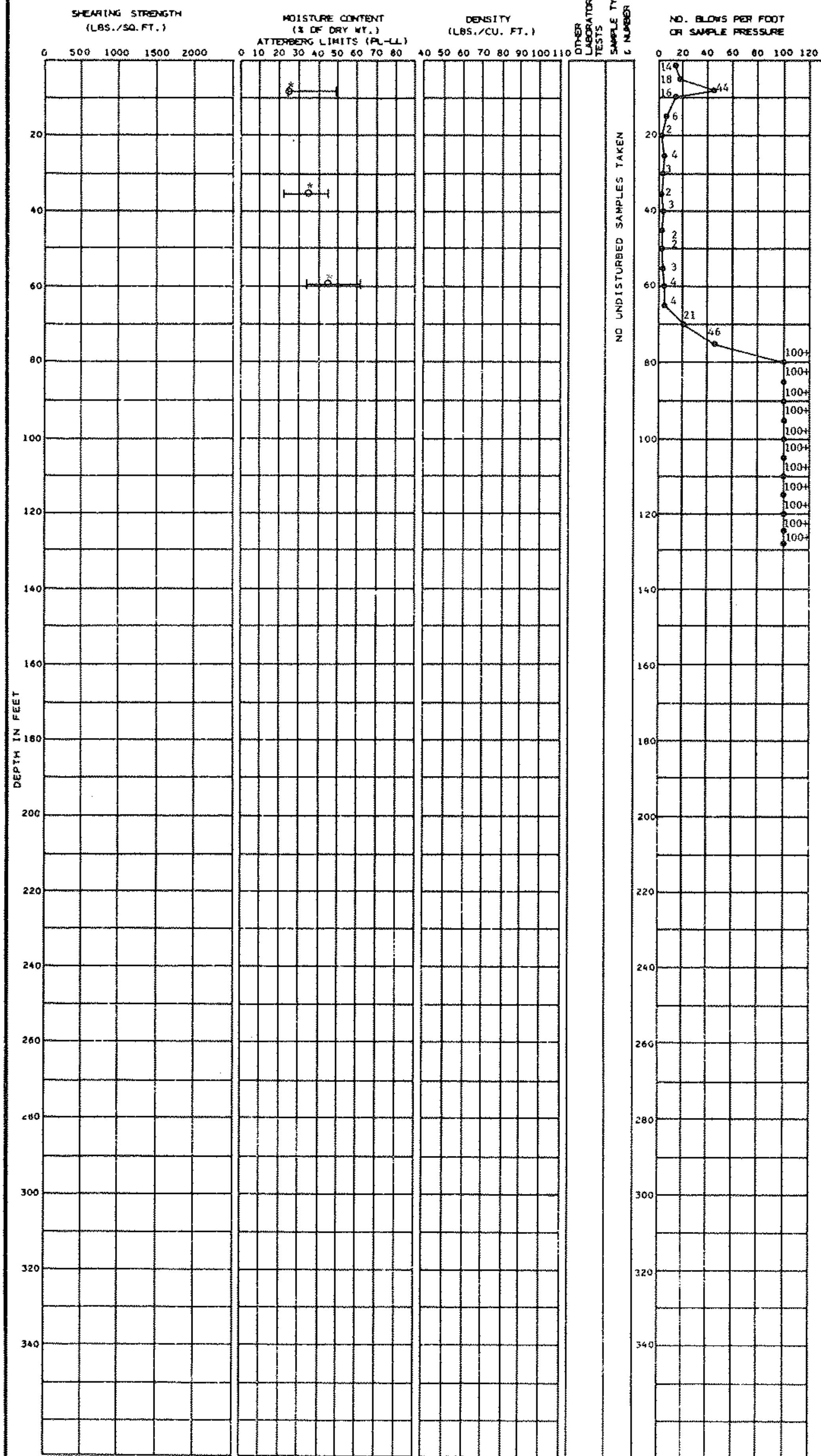
BECHTEL Belle River

LOCATION: N 10,050 E 4,995

GROUND ELEVATION: 594.6

DATE DRILLED: 3-5-74 3-7-74

SHEET 1 OF 1



DESCRIPTION

Clay topsoil

Stiff, brown and gray, silty clay (CL-CH) some fine sand

Hard

Stiff, brown

Plastic, gray, trace fine sand

Very soft to soft, gray, silty clay (CH)

Soft, moderate to high plasticity, gray, silty Clay (CL)

Soft to firm, highly plastic, dark gray, silty Clay (CH) 5% fine sand

Firm, gray, silty clay (CL), some fine sand

Hard, very sandy

Very compact, gray, clayey very fine sand (SC)

Compact, gray, very fine sand (SP)

Blowcount refusal possible boulder

Bottom of hole - Elevation - 456.1
- Depth - 128.5 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and Natural Soil

o Water Content

├─┤ Atterburg Limits

* Water content taken from unsealed jar sample.

SOIL BORING NO. 134

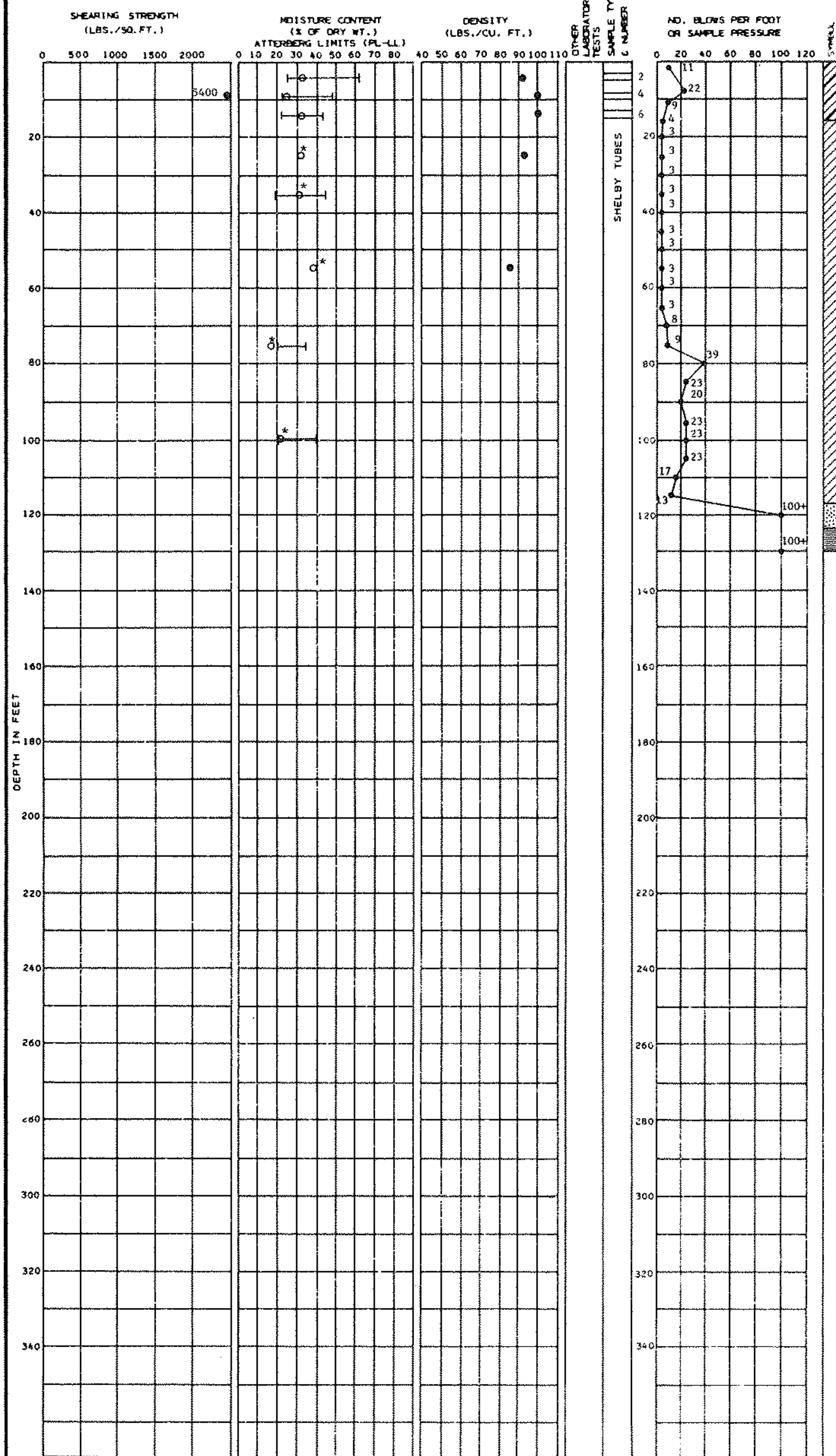
BECHTEL Belle River

LOCATION: N 10,050 E 7,000

GROUND ELEVATION 590.2

DATE DRILLED: 3-8-74 3-13-74

SHEET 1 OF 1



DESCRIPTION

Plastic, brown, silty clay (CL-CH) some fine sand

Stiff, brown and gray

Hard, mottled gray, 15% fine to coarse sand

Very soft to soft, moderately plastic, gray, silty Clay (CL)

10% fine to coarse sand

plastic, gray, some fine sand

low to moderate plasticity, 25% fine to coarse sand

very stiff, fine sandy

Firm, some fine sand

15% fine to coarse sand

Plastic, trace fine sand

Compact, gray, fine sand (SP)

124.0-130.0 ft shale, black, laminated, medium hard

Bottom of hole - Elevation - 460.2
- Depth - 130.0 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

● Unconfined Compression

o Moisture Content

├─┤ Atterburg Limits

* Water content taken from unsealed jar sample.

SOIL BORING NO. 136

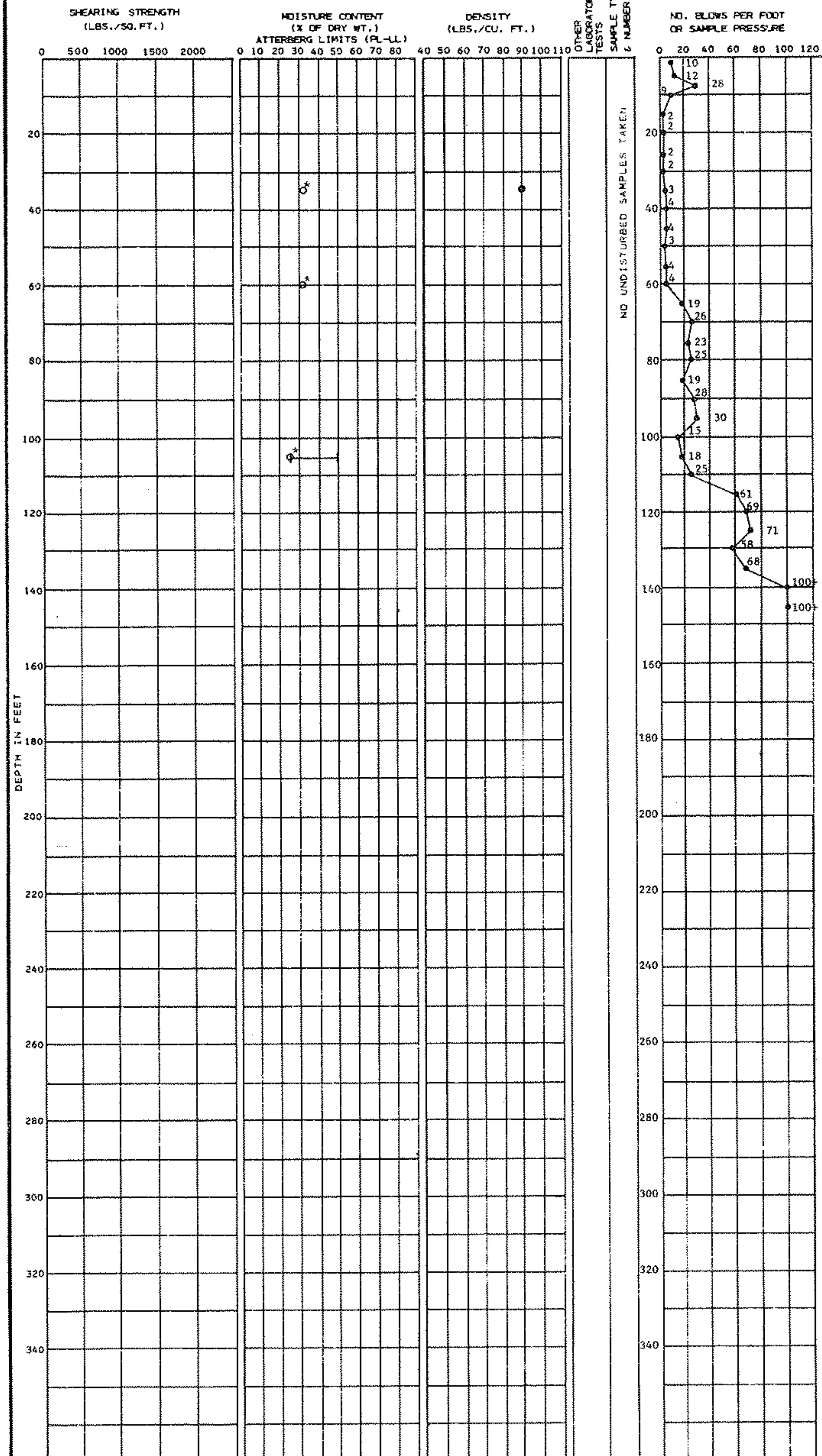
BECHTEL Belle River

LOCATION: 10,030 / 5,977

GROUND ELEVATION: 588.7

DATE DRILLED: 3-11-74 / 3-14-74

SHEET 1 OF 1



DESCRIPTION

- peaty, sandy topsoil
- firm, brown, silty Clay (C.-CH) some fine sand
  - stiff, sandy
  - plastic, gray, trace fine sand
- very soft to soft, gray, silty Clay (CH)
- soft to medium, moderate to high plasticity, gray, silty Clay (CL)
  - firm, some fine sand
- medium compact, gray, clayey silt (ML)
- firm, gray, silty Clay (CL) some fine sand
  - stiff
  - plastic
  - highly plastic
- compact, gray, very fine Sand (SP) trace silt
- compact, gray, very fine to medium Sand (SP) trace gravel
- hard, gray, sandy, silty Clay (CL) few pebbles (Hardpan)
- 144.0-145.0ft Shale, gray, medium hard

Bottom of Hole-Elevation-443.7
-Depth-145.0ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

o Water Content
|—| Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 138

BECHTEL Belle River

LOCATION: 10,850 [illegible] .003

GROUND ELEVATION 592.0

DATE DRILLED: 3-19-74 3-20-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

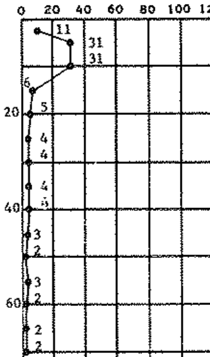
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120



SYMBOL

DEPTH IN FEET

DEPTH IN FEET	DESCRIPTION
0–20	plastic, brown, silty Clay (CL) trace sand stiff, some fine sand soft, gray
20–70.5	very soft to soft, gray, silty Clay (CH)
70.5	Bottom of Hole-Elevation 521.5 -Depth-70.5ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

SOIL BORING NO. 140

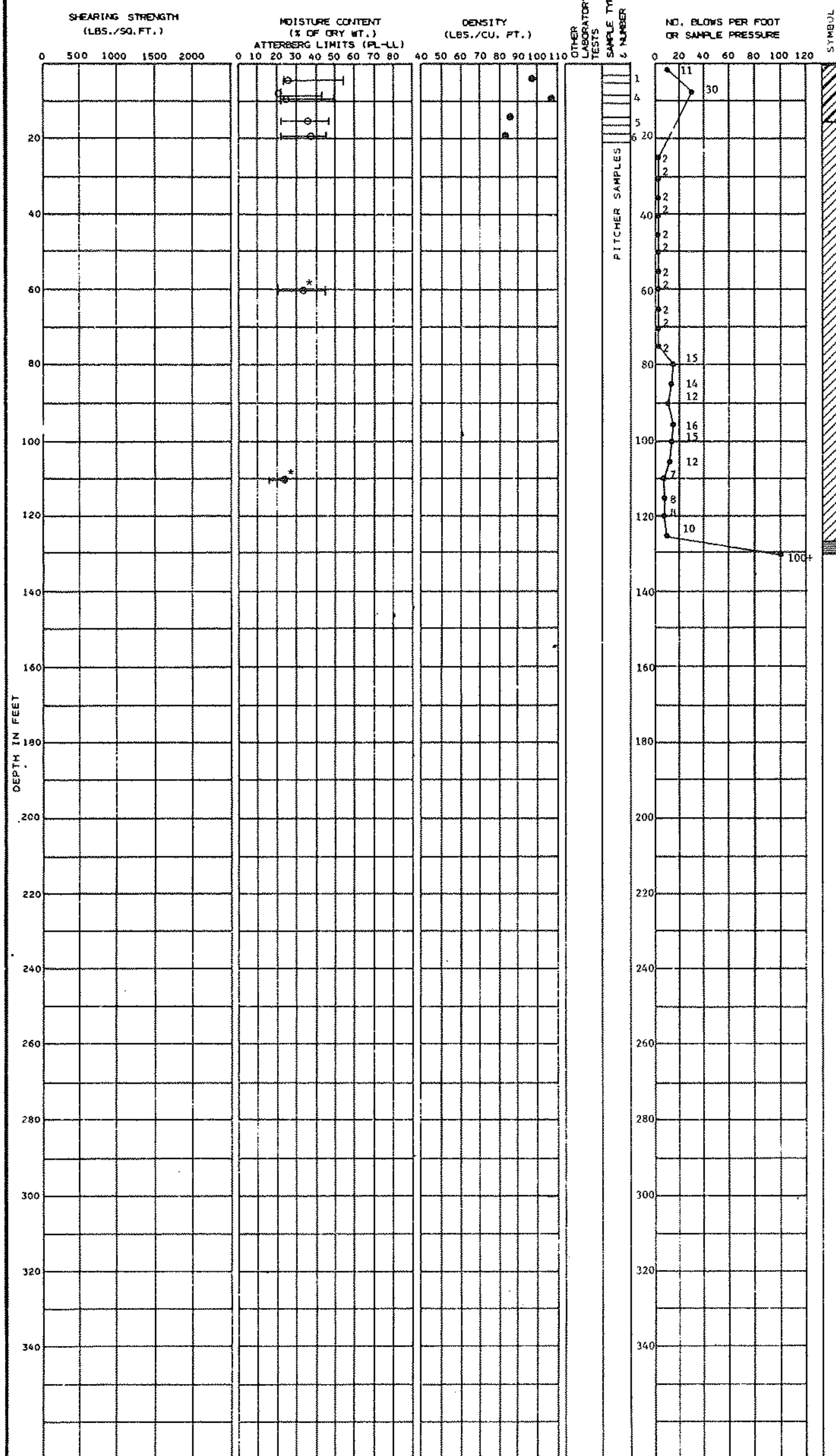
BECHTEL Belle River

LOCATION: N 11,146 E 7,995

GROUND ELEVATION: 589.0

DATE DRILLED: 3-25-74 3-27-74

SHEET 1 OF 1



DESCRIPTION

black, clayey topsoil

medium, brown, silty Clay (CL-CH) some sand

very stiff, mottled brown & gray, high plasticity

very stiff, olive brown, moderate to high plasticity

firm, moderate to high plasticity, gray, silty Clay (CL)

medium, 15% fine to coarse sand and fine gravel

grayish brown

firm, gray, some sand and gravel

medium, silty fine sandy, trace gravel

25-30% fine to medium sand

127.0-130.8ft Shale, gray, soft, fractured, horizontal bedding, moist

Bottom of Hole-Elevation-458.2 -Depth-130.8ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and soil

o Moisture Content
├─┤ Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 142

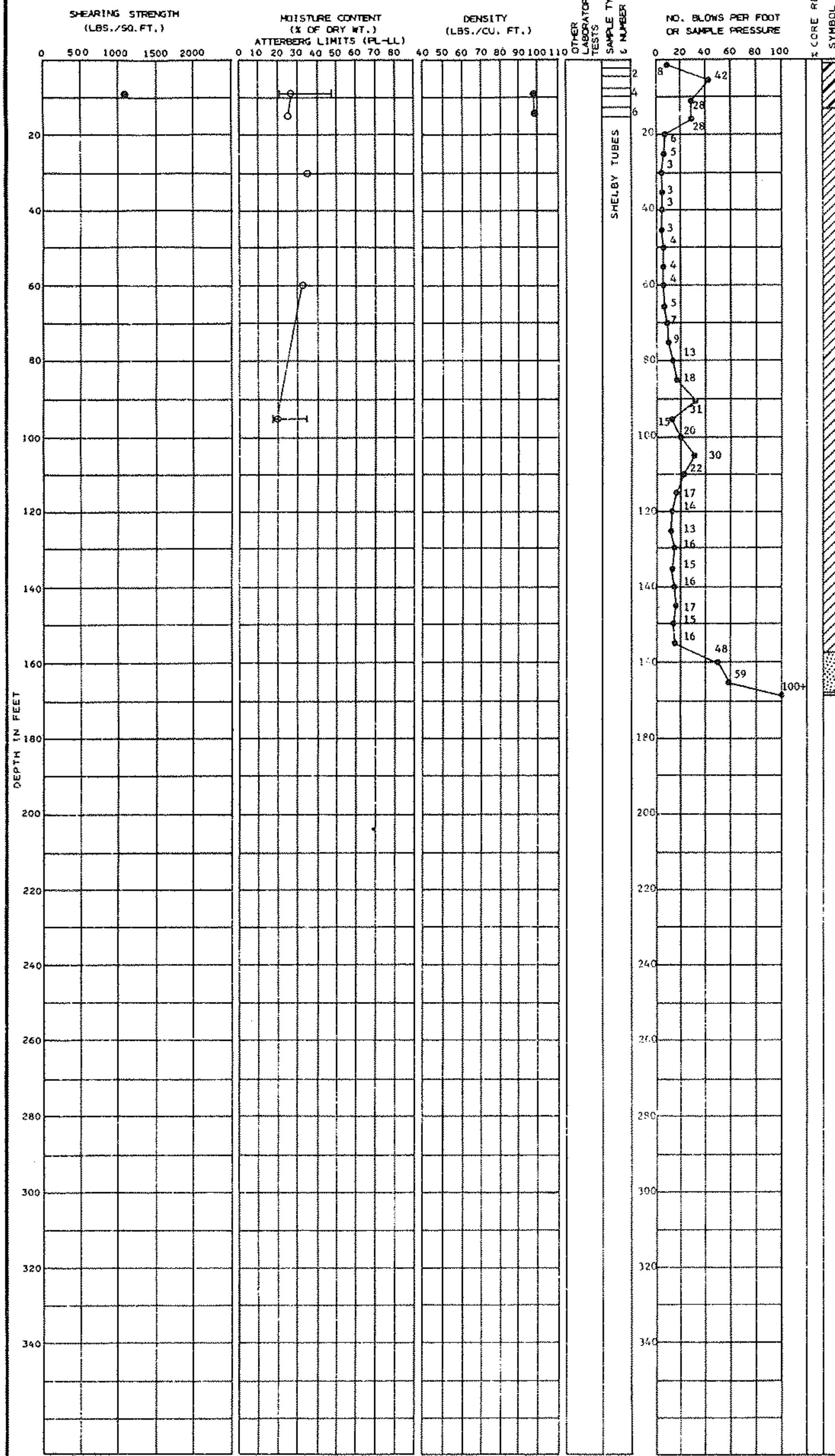
BECHTEL Belle River

LOCATION: N 12,000 E 5,000

GROUND ELEVATION 597.5

DATE DRILLED: 3-13-74 3-15-74

SHEET 1 OF 1



DESCRIPTION

topsoil

very stiff, gray-brown, silty Clay (CL-CH) some fine sand

brown, highly plastic, 20-25% fine to coarse sand and fine gravel

soft, gray, silty Clay (CL) slight trace very fine sand

5% fine to coarse sand

stiff, some fine sand, few stones

moderately plastic, 15% fine to coarse sand

very compact, gray sand (SW), medium to coarse, trace gravel

168.0-168.16 ft shale, soft, gray

Bottom of Hole - Elevation - 429.34
- Depth - 168.16 ft

Water lost in this hole -
25 gallons 57.0 ft

For Water Table information consult Section 4.1.3.

Hole backfilled with bentonite and natural soil

● Unconfined Compression

○ Moisture Content

├─┤ Atterburg Limits

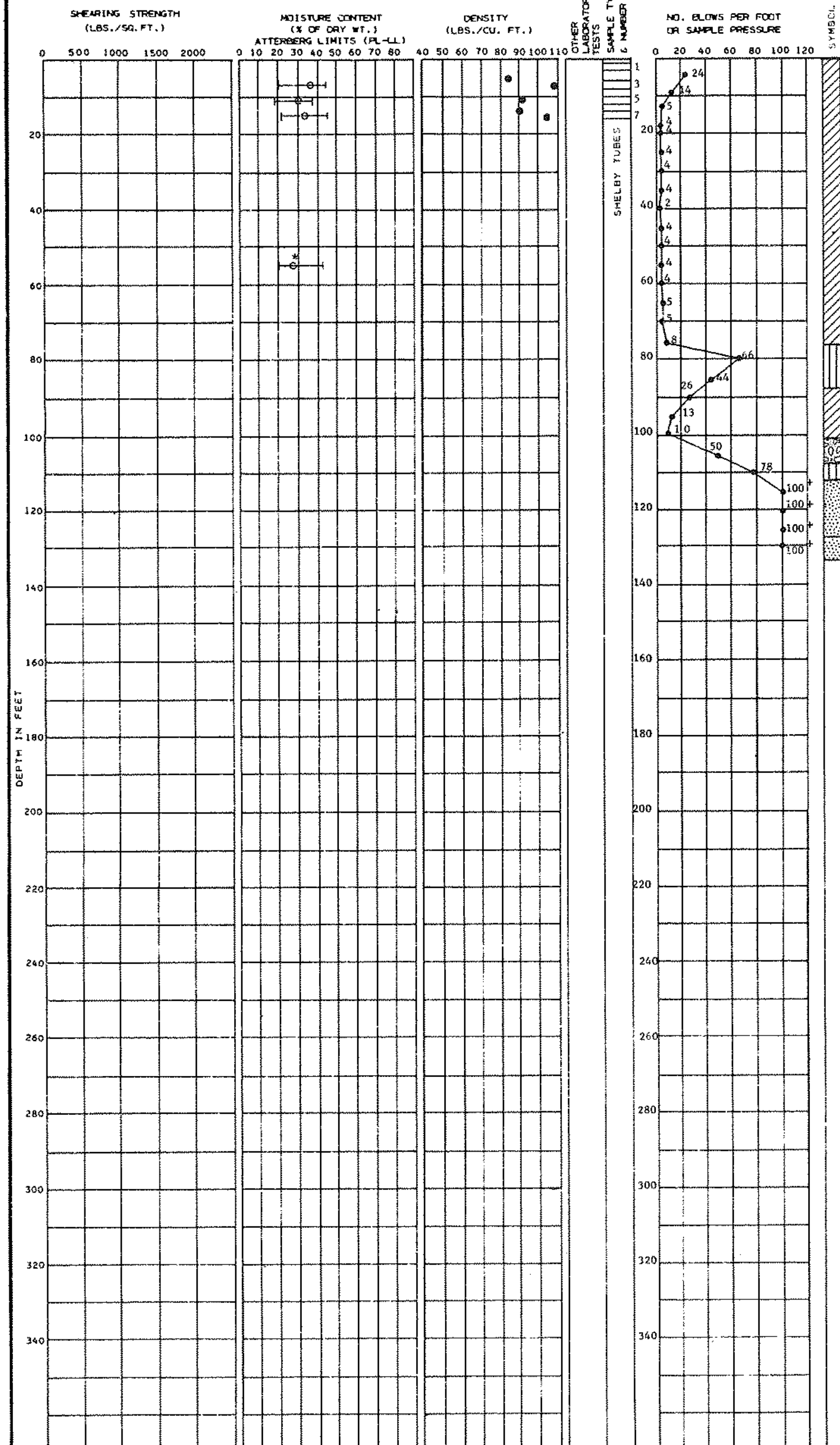
SOIL BORING NO. 144

BECHTEL Belle River

LOCATION: N 12,000 E 7,000 GROUND ELEVATION 589.7

DATE DRILLED: 3-18-74 3-19-74

SHEET 1 OF 1



DESCRIPTION

- topsoil
- stiff, brown & gray, silty Clay (CL) some fine sand
- gray & brown, moderate plasticity, trace sand
- 40% fine to coarse sand & fine gravel
- very soft to soft, brown, moderate to high plasticity, 5% fine to coarse sand
- grayish brown
- compact, gray Clayey fine Sand (ML) trace pebbles
- stiff, gray, fine sandy, silty Clay (CL)
- plastic, trace fine sand
- boulder
- compact, gray, sandy Silty Gravel (GM)
- compact, gray, clayey Silt (ML)
- very compact, gray, very fine Sand (SP)
- gravelly Sand (SW)
- boulder

Bottom of Hole - Elevation - 455.7
- Depth - 134.0 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

Moisture Content
Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 146

BECHTEL

LOCATION: N 13,061 E 5,006

GROUND ELEVATION 598.6

DATE DRILLED: 3-28-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN	11, 13, 12, 15		Black, clayey topsoil Firm, brown & gray, silty, sandy clay (CL), trace of pebbles
					4, 4, 4, 4, 2, 3, 3, 3, 2, 2, 2, 2		Soft, gray, silty clay (CH), trace of sand
							Bottom of hole - Elevation - 528.6 - Depth - 70.0 ft

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil

SOIL BORING NO. 148

BECHTEL Belle River

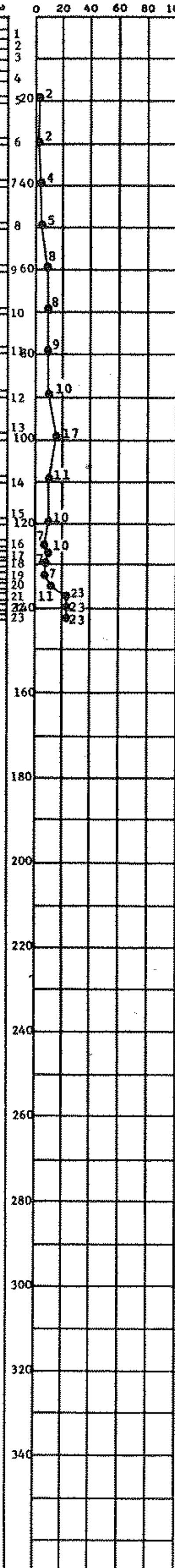
LOCATION: N 7455 E 9535

GROUND ELEVATION 585.2

DATE DRILLED: 9/28/77 9/30/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			



DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

% CORE RECOVERY: 92, 88, 100, 100

DESCRIPTION

0-0.7' Topsoil, dark brown, clayey

0.7-12.0' Silty Clay, dark brown, vary stiff, med. plasticity, moist, trace wood fragments, trace sand, trace fine gravel (CL)

12.0-58.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt, trace sand, trace fine gravel (CH)

38.5'-58.0' Soft

58.0-129.8' Silty Clay, med. gray, med. stiff, med. plasticity, moist, little sand, trace fine to coarse gravel (CL)

98.5-108.5' Very stiff

108.5-118.5' Stiff

118.5-129.8' Trace sand

129.8-136.0' Clayey Silt, med. gray, med. stiff to stiff, wet, with occasional fine-grained sand seams (ML)

136.0-140.5' Clayey Sand, med. gray, med. dense, wet, fine-grained, scattered silt layers, trace fine to med. gravel (SC)

140.5' Top of Rock

140.5-162.0' Shale, med. gray, soft, weathered

144.0-158.7' Firm, scattered soft clay layers

156.0' Irregular bedding

158.7-162.0' Hard, dark gray, occasional soft clay layers

Bottom of Hole: Depth 162.0'
Elevation 423.2

Hole grouted from 162.0' to ground surface.

SOIL BORING NO. B-8

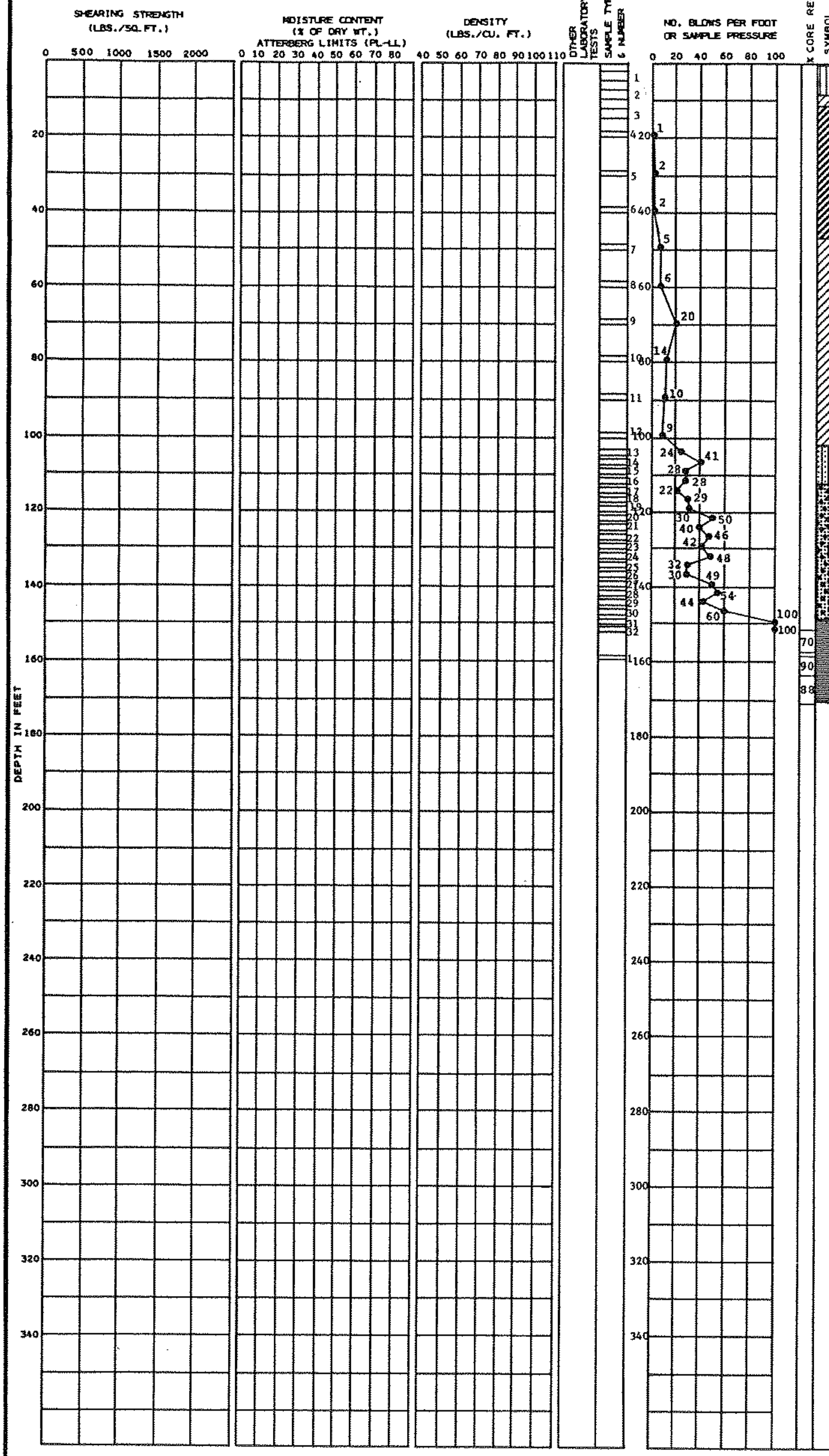
BECHTEL Belle River

LOCATION: N 7675 E 9100

GROUND ELEVATION 585.6

DATE DRILLED: 8/8/77 8/11/77

SHEET 1 OF 1



DESCRIPTION

0-0.3' Topsoil, clayey silt, med. brown, dry

0.3-8.5' Clayey Silt, green brown and med. gray, mottled, slight plasticity, dry, trace wood fragments, trace fine gravel (ML)

8.5-11.5' Silty Clay, med. gray and brown, mottled, high plasticity, wet, trace silt, trace fine gravel (CL)

11.5-46.5' Clay, med. gray, very soft, very high plasticity, wet, trace silt, trace fine gravel (CH)

46.5-101.5' Silty Clay, med. gray, soft to med. stiff, med. plasticity, moist, little sand, trace fine to coarse gravel, occasional cobble(CL)
48.5-50.0' Seams of clayey sand and silt
68.5-78.5' Very stiff
78.5-88.5' Stiff
83.0-83.5' Cobble
88.5-101.5' Med. stiff

101.5-111.0' Silty Sand, med. gray and brown, med. dense, fine-to med.-grained, wet, with silt seams (SM)

111.0-150.5' Sand, med. gray and brown, med. dense, fine-to coarse-grained, wet, trace silt, trace fine to coarse gravel, very clean, occasional cobbles (SW-SP)
121.0-133.5' Fine-to med.-grained
128.5-133.5' Silty
133.5-148.5' Med.-to coarse-grained
143.0-148.5' Some fine to coarse gravel
148.5-150.5' Fine-to med.-grained

150.5' Top of Rock
150.5-171.0' Shale, med. gray to dark gray, soft to moderately hard
150.5-158.9' Soft, weathered, mechanically fractured
158.9-171.0' Moderately hard, occasional mechanical fractures at 45° angle, occasional soft shale seams
163.5-164.0' Fissile, core broken every 1/4"

Bottom of Hole: Depth 171.0'
Elevation 414.6

Hole caved in from 171.0' to 145.0'.

Hole grouted from 145.0' to ground surface.

SOIL BORING NO. B-9

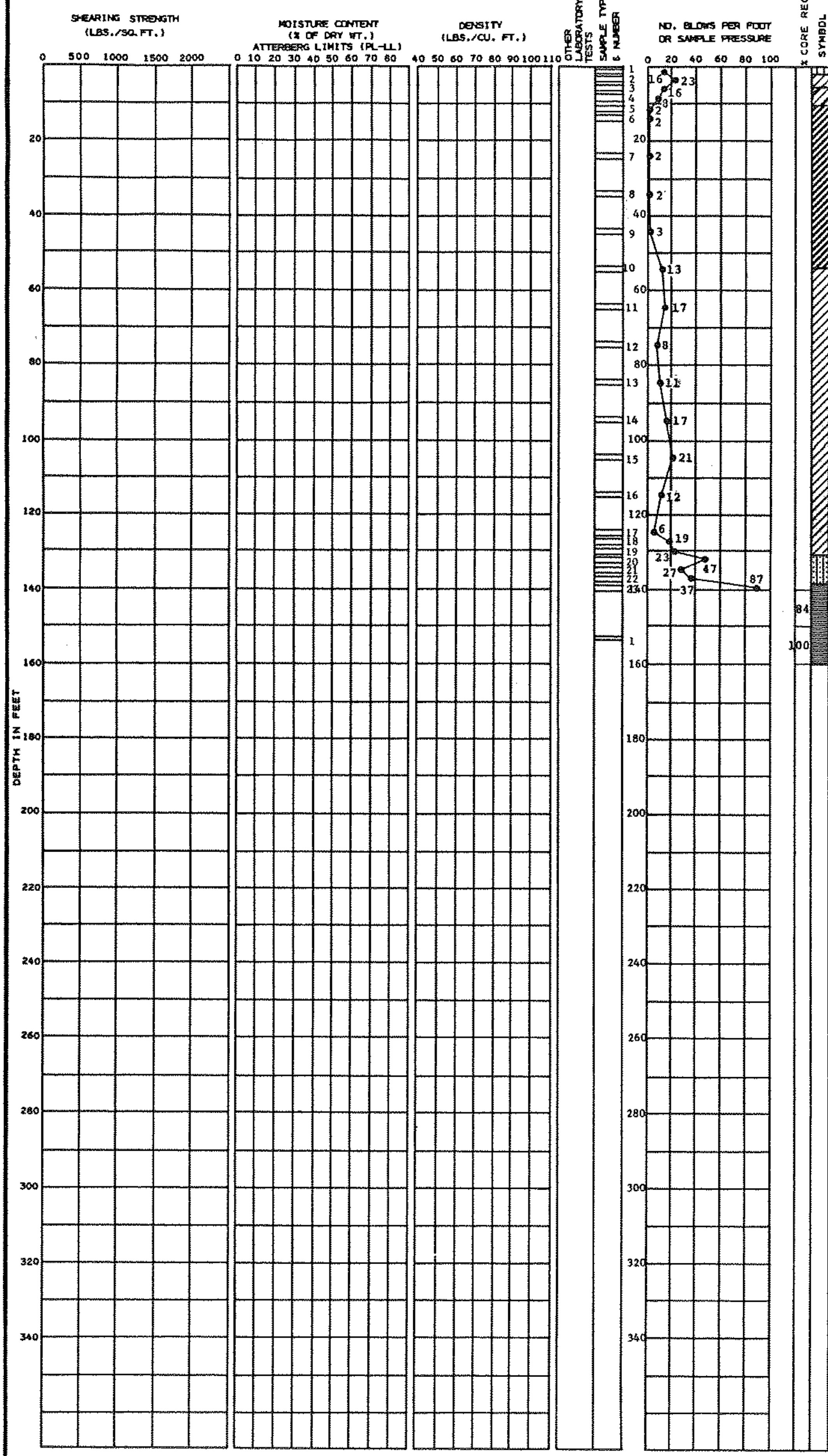
BECHTEL Belle River

LOCATION: N 7500 E 9388.7

GROUND ELEVATION 585.3

DATE DRILLED: 7/21/77 7/25/77

SHEET 1 OF 1



DESCRIPTION

0-1.0' Clayey Silt, topsoil, light gray to dark brown, med. dense, dry, with wood fragments (ML)

1.0-6.0' Silty Clay, med. brown and light gray, mottled, very stiff, med. plasticity, moist, trace sand (CL)

6.0-11.0' Clay, med. brown, very stiff, med. plasticity, moist, trace silt, trace sand (CL-CH)
7.5-11.0' Light gray, med. stiff, high plasticity

11.0-54.0' Clay, light gray, very soft, very high plasticity, wet (CH)

54.0-131.0' Silty Clay, med. gray, stiff, high plasticity, moist, trace sand, trace cobble (CL)
63.5-73.5' Very stiff

73.5-83.5' Med. stiff

83.5-93.5' Stiff, trace fine to coarse gravel

93.5-113.5' Very stiff

100.5-123.5' Med. plasticity, little sand
113.5-126.0' Stiff

123.5-124.0' Fine-grained clayey sand seam
126.0-131.0' Very stiff
126.5-127.0' Fine-grained silty sand seam

131.0-138.0' Silty Sand, med. gray, dense, wet, fine-grained (SM)
Cobble on top of rock

138.0' Top of Rock
138.0-160.0' Shale, dark gray, soft to firm, fissile mechanically fractured in areas
138.0-141.4' Soft, weathered
141.4-160.0' Hard, fissil

Bottom of Hole: Depth 160.0'
Elevation 425.3

Hole grouted from 160.0' to ground surface.

SOIL BORING NO. B-12

BECHTEL Belle River

LOCATION: N 13,000 E 7,000

GROUND ELEVATION 590.6

DATE DRILLED: 3-27-74 3-28-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

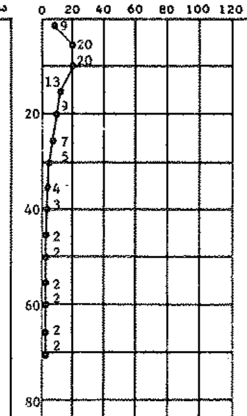
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE



SYMBOL

DEPTH IN FEET 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

DESCRIPTION

black, clayey topsoil

medium, brown, silty Clay (CL) trace of sand and gravel

— gray, silty

soft, gray, sandy, silty Clay (CH)

— no sand

Bottom of Hole-Elevation-520.1
-Depth-70.5ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and soil

SOIL BORING NO. 150

BECHTEL Belle River

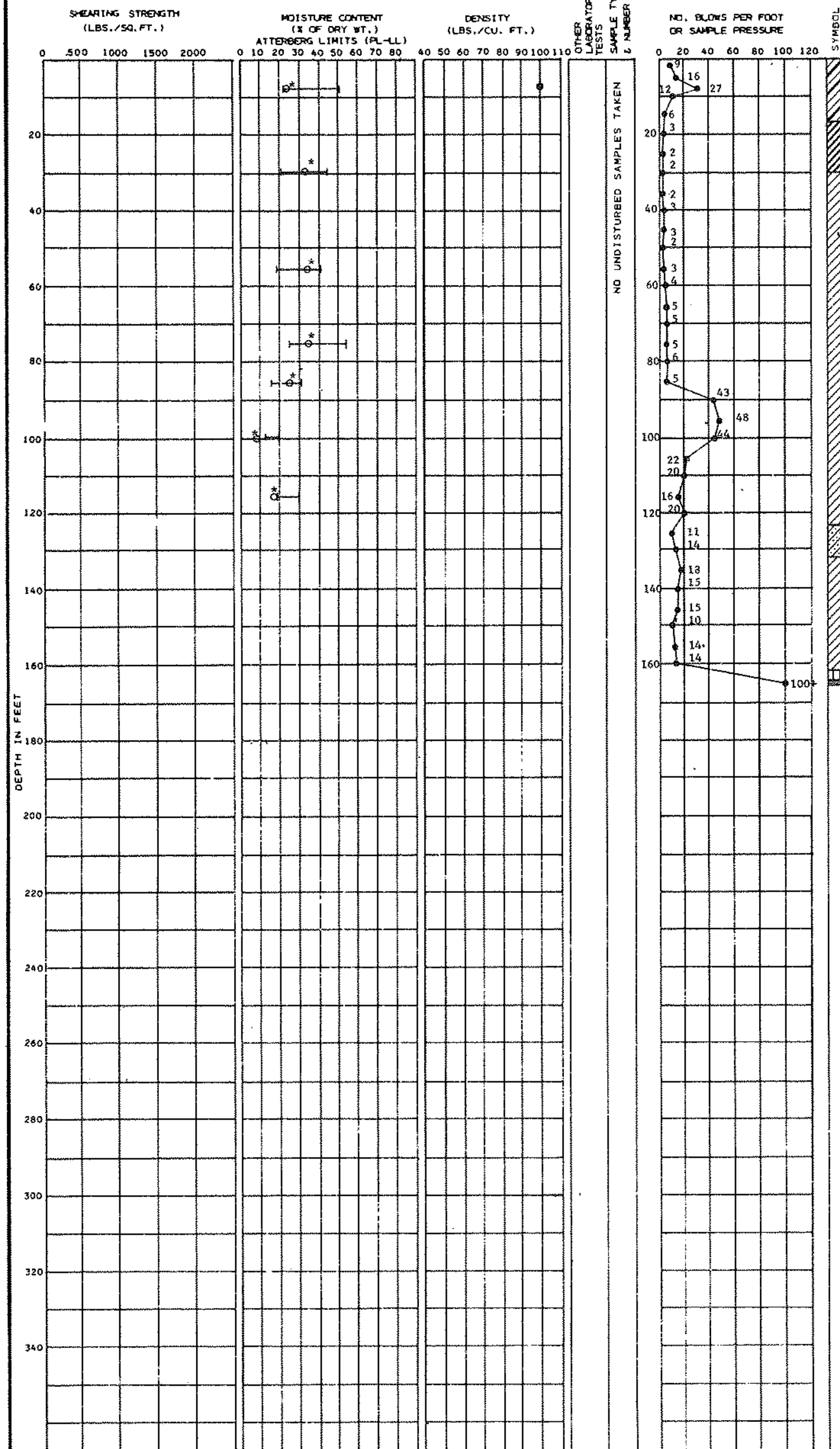
GWHH 10-72*

LOCATION: N 13,785 E 5,006

GROUND ELEVATION: 599.0

DATE DRILLED: 3-7-74 3-14-74

SHEET 1 OF 1



DESCRIPTION

firm, brown, leached Clay (CL-CH) trace fibers and topsoil

stiff, brown and gray, silty clay, trace fine sand, few pebbles

soft to plastic, gray, some fine sand

very soft to soft, gray, silty Clay (CH)

soft, moderately plastic, grayish brown, silty Clay (CL) 10% fine to coarse sand

– 5% fine to coarse sand

– soft to plastic, gray, some fine sand

– highly plastic

– 25% fine to coarse sand

– very stiff, very sandy clay, few pebbles

– low plasticity, clayey silt (CL-ML)

– lense, 15% fine to medium sand

firm to stiff, silty, some fine sand

– 10% fine sand, low plasticity

medium compact, gray, Clayey Sand (SC) fine to medium

plastic to firm, gray, silty Clay (CL) some fine sand

clayey Silt (ML)

164.0-165.0ft Shale, gray, soft

Bottom of Hole-Elevation-434.0
-Depth-165.0ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

o Moisture Content

├─┤ Atterburg Limits

* Water content taken from unsealed jar sample.

SOIL BORING NO. 154

BECHTEL Belle River

LOCATION: N 14,000 E 8,000

GROUND ELEVATION 591.5

DATE DRILLED: 4-5-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120	SYMBOL	DESCRIPTION
				NO UNDISTURBED SAMPLES TAKEN	8, 14, 30, 22, 8, 7, 4, 4, 4, 3, 2, 2, 2, 2, 2, 3		topsoil firm to stiff, brown, silty clay (CL) very stiff, trace gravel plastic to firm, gray soft, gray, silty clay (CH)

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

Bottom of Hole - Elevation - 521.5
- Depth - 70.0 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

SOIL BORING NO. 157

BECHTEL Belle River

LOCATION: N 14,000 E 9,950

GROUND ELEVATION 591.3

DATE DRILLED: 4-3-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO UNDISTURBED SAMPLES TAKEN

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120

Blow counts (top to bottom): 10, 9, 17, 14, 15, 7, 4, 5, 2, 2, 2, 2, 3, 4, 4, 5

SYMBOL

DEPTH IN FEET 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

DESCRIPTION

gray silt (ML)

loose to medium compact, brown to gray, silty sand (SM) fine to medium

firm, gray, silty clay (CL)

soft, gray, silty clay (CH)

Bottom of Hole - Elevation - 521.3
- Depth - 70.0 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel in soil

SOIL BORING NO. 159

BECHTEL Belle River

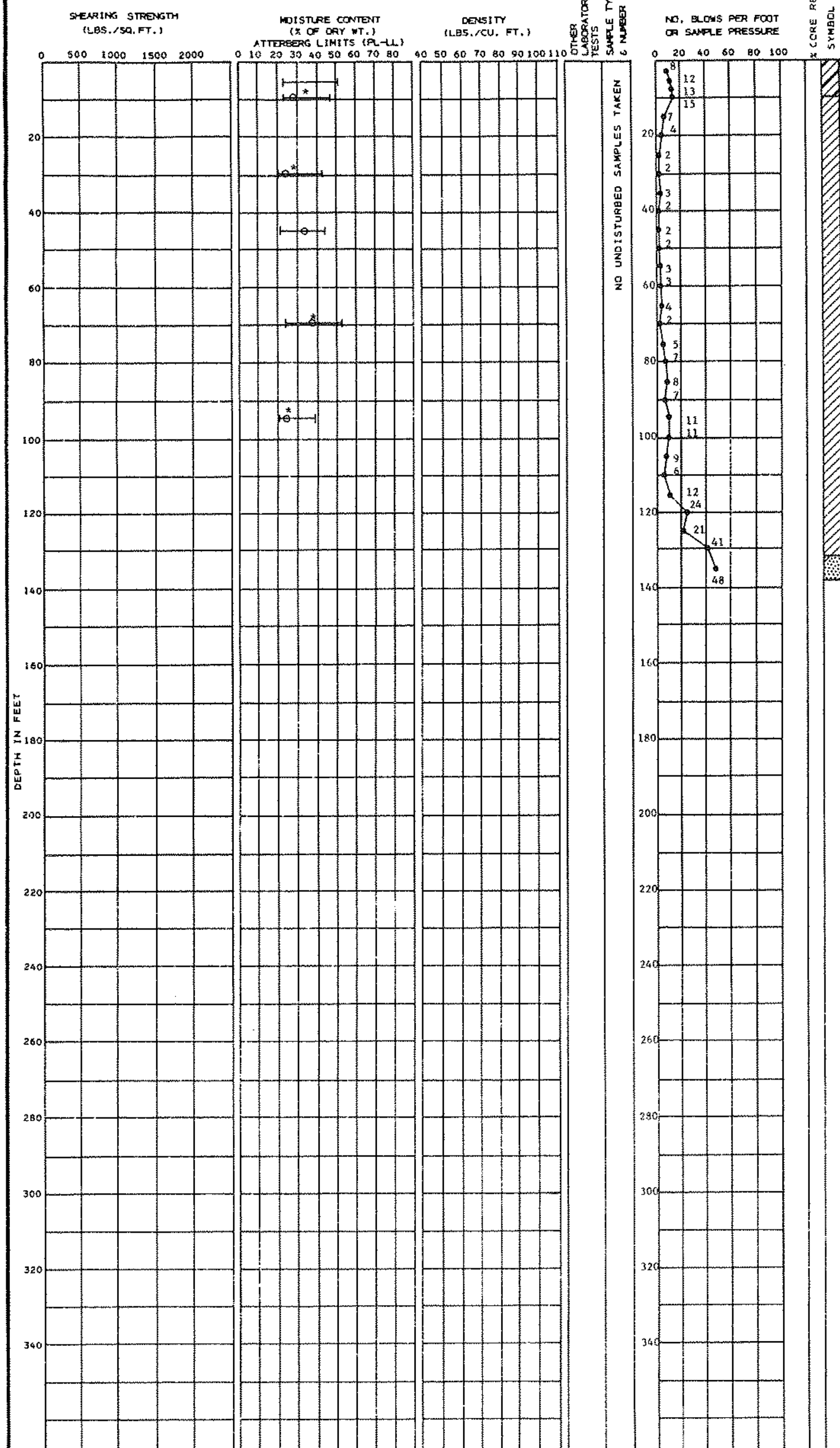
DUNN 10-72F

LOCATION: N 15,000 E 8,000

GROUND ELEVATION 591.4

DATE DRILLED: 4-8-74

SHEET 1 OF 1



DESCRIPTION

plastic, gray, silty Clay (CL-CH)
firm, gray and brown, trace fine sand

plastic, gray, some fine sand

medium, grayish brown, moderately to highly plastic, silty Clay (CL)
very soft to soft, gray

moderately plastic

5% fine to medium sand

soft to plastic, trace fine sand

highly plastic

plastic, some fine sand

10% fine to coarse sand

firm, few sand seams

very stiff, sandy, few pebbles

medium compact, gravelly Sand (SW)
seams of fine sand

Bottom of Hole-Elevation-453.4
-Depth-138.0ft

Unable to keep this boring open below 138.0' due to gravel.

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and Natural Soil.

O Moisture Content

├─┤ Atterburg Limits

* Water content taken from unsealed jar sample.

SOIL BORING NO. 163

BECHTEL Belle River

LOCATION: N 14,830 E 9,938

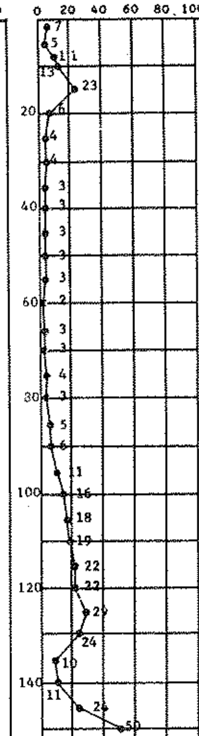
GROUND ELEVATION 594.3

DATE DRILLED: 3-26-74 3-27-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110		NO UNDISTURBED SAMPLES TAKEN	0 20 40 60 80 100			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

Loose to medium compact, brown, fine to medium sand (SW) trace fine gravel

Stiff, gray, silty clay (CL)
— medium, some sand

soft, gray, silty clay (CH)

Medium, gray, sandy, silty clay (CL) some gravel

— firm, trace of sand and gravel

— medium, silty

medium compact, gray, silty sand (SM) fine

compact, gray, fine to medium gravel (GW) with fine to coarse sand

156.0 - 156.5 ft. shale

Bottom of Hole - Elevation - 437.8
- Depth - 156.5 ft.

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Bentonite and soil

SOIL BORING NO. 165

BECHTEL Belle River

LOCATION: N 3,525 E 12,533

GROUND ELEVATION 590.8

DATE DRILLED: 3-5-74 3-7-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

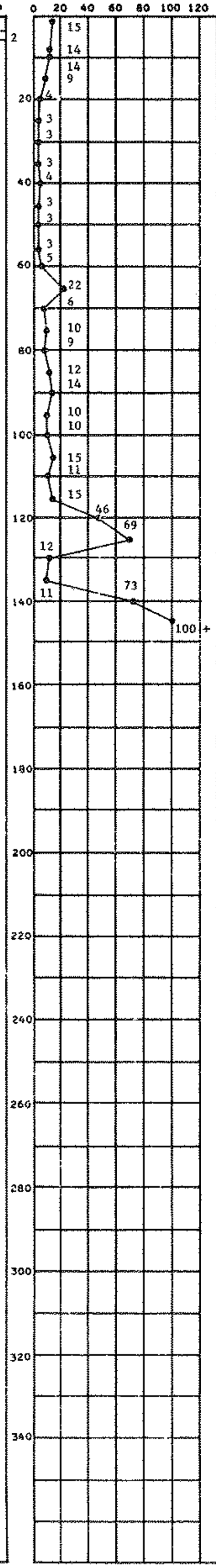
DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER: SHELBY TUBES 2

DEPTH IN FEET 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100 120



SYMBOL

DESCRIPTION

cinders, fill

stiff, brown and gray, silty Clay (CL) some fine sand

firm, gray, trace fine sand

▽ 4-25-74 Elevation of water-578.3 Depth of water-10.0 ft.

Very soft to soft, gray, silty clay (CH)

plastic, gray, silty Clay (CL) some fine sand

compact, dark gray, Clayey Sand (SC) few pebbles

plastic to firm, gray, silty Clay (CL) some fine sand

compact, gray, very fine Sand (SP)

plastic, gray, silty Clay (CL) trace fine sand

compact, gray, clayey Silt (ML)

143.5 - 144.0ft Shale, soft, gray

Bottom of Hole-Elevation-446.8 -Depth-144.0ft

No gain or loss of water

Piezometer Installation:
3 feet of 2 inch pvc blank casing from 144.0 to 141.0 feet, 4 feet of #80 screen from 141.0 to 137.0 feet, 141.3 feet of 2 inch pvc casing from 137.0 to 4.3 feet above ground surface, backfilled with sand around screen, annulus backfilled with bentonite and soil to ground surface.

For Water Table information consult Section 4.1.3.

SOIL BORING NO. 181

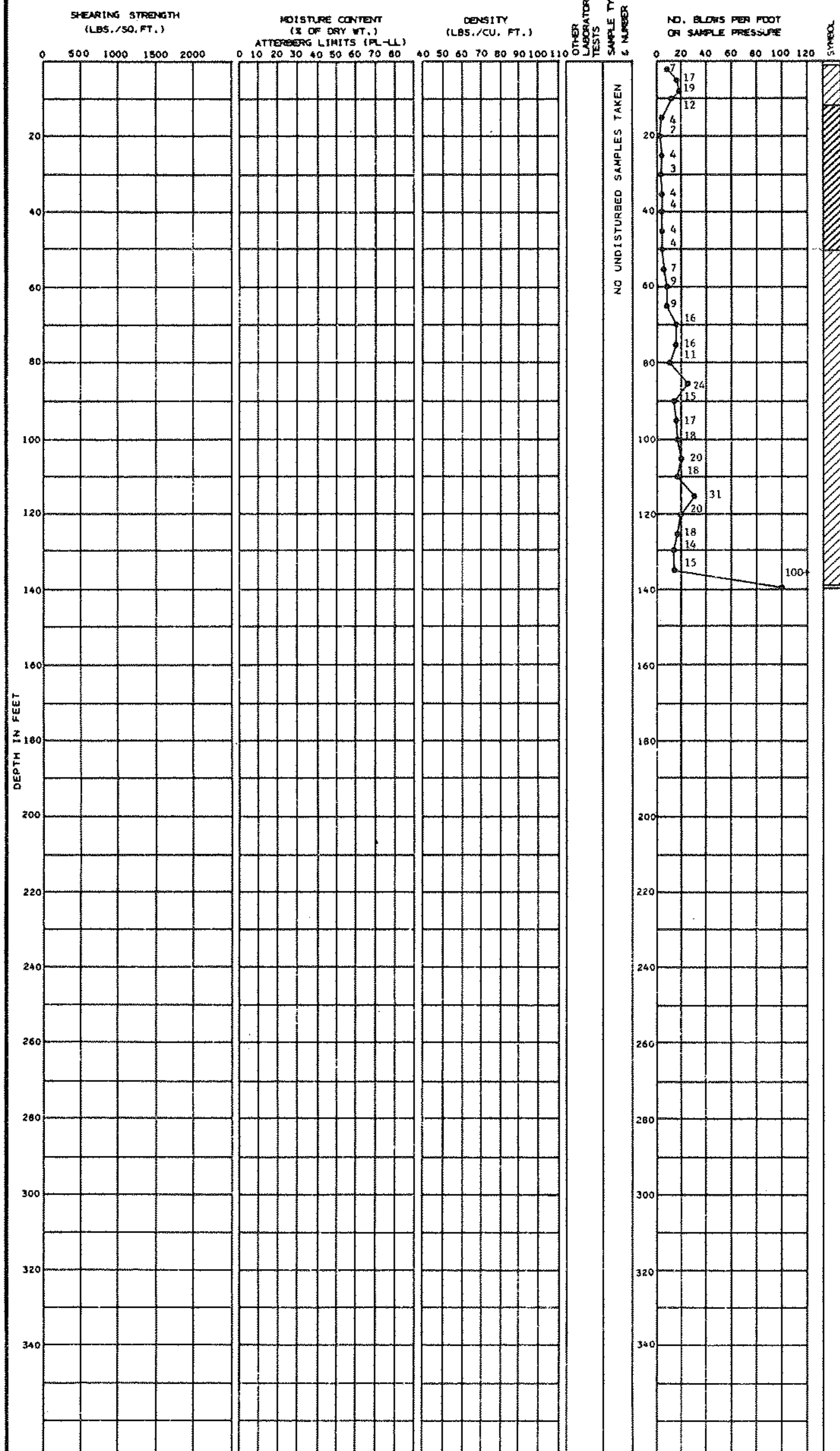
BECHTEL Belle River

LOCATION: N 3,556 E 9,564

GROUND ELEVATION 586.1

DATE DRILLED: 3-15-74 3-19-74

SHEET 1 OF 1



DESCRIPTION

topsoil

Stiff, brown, silty clay (CL), trace fine sand, some gray mottling

Very soft to soft gray, silty clay (CH)

Plastic, gray, silty clay (CL), some fine sand

Plastic to firm, some fine sand, few pebbles

138.5-139.92 ft shale, gray, soft

Bottom of hole - Elevation - 446.18
" - Depth - 139.92 ft

No gain or loss of water

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and soil

SOIL BORING NO. 184

BECHTEL Belle River

LOCATION: N 5,500 E 9,797

GROUND ELEVATION 586.8

DATE DRILLED: 2-26-74 2-27-74

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET

Depth (ft)	Sample No.	Blows per foot	Description
0–20	5	3, 22, 34, 15, 3	Very soft, brown & gray, silty, sandy Clay (CL-CH); stiff, brown, silty, some fine sand; gray mottling; plastic, gray, some fine sand; Very soft to soft, gray, silty Clay (CH)
20–60	7, 9, 11, 13	3, 3, 3, 3	Soft, moderate to high plasticity, gray, silty Clay (CL); soft to firm, 20% fine to coarse sand
60–100	15, 19, 21	4, 52, 44, 21, 19, 49	stiff, sandy, with silt & sand lenses; firm to stiff, few pebbles; moderate plasticity, 20% fine to coarse sand
100–120		33, 6, 54, 12	Compact, gray Silt (ML) trace of clay & 20% fine sand, nonplastic; Hard, gray, sandy Clay (CL) some pebbles; plastic to firm, silty, some fine sand
120–140	28	12, 23, 100+	Compact, gray, very fine Silty Sand (SM); Very hard, gray, sandy Clay (CL) some pebbles; 139.0-139.3 Shale, gray, soft

Bottom of Hole - Elevation - 447.5
- Depth - 139.3 ft

No gain or loss of water.

For Water Table information consult Section 4.1.3.

Hole backfilled with Quik-Gel and natural soil.

O Moisture Content
├─┤ Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 186

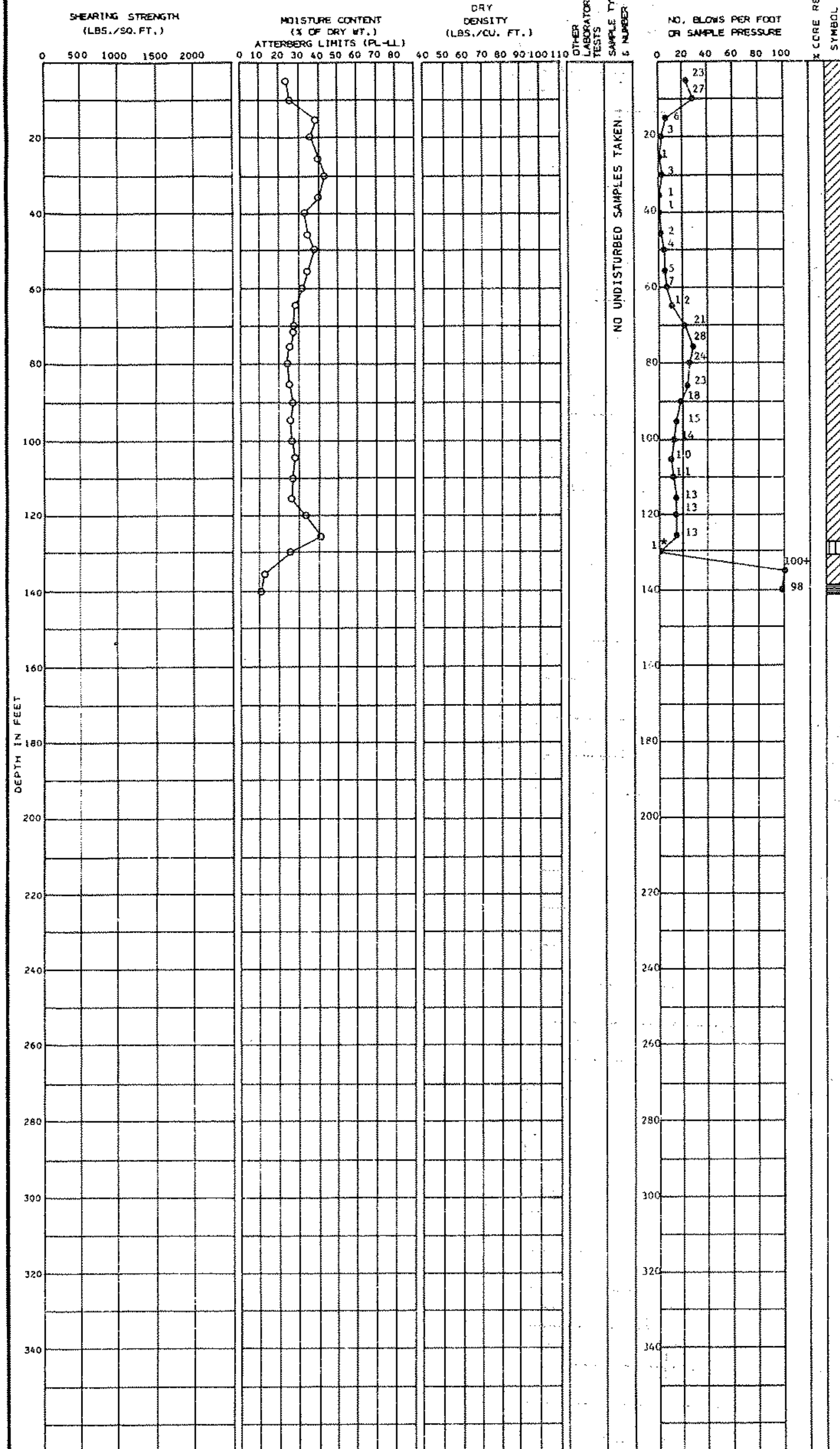
BECHTEL Belle River

LOCATION: N 3500 E 11741

GROUND ELEVATION: 585.2

DATE DRILLED: 8/6/75 8/8/75

SHEET 1 OF 1



DESCRIPTION

Medium stiff, mottled brown & gray, slightly moist, silty Clay (CL) trace shale fragments

brown

very soft, gray, moist

trace very fine sand and pebbles

very slight trace sand

trace sand

medium stiff

stiff, trace sand and very fine gravel

hard, trace to little sand and very fine gravel

stiff

less very fine gravel

medium stiff

Very soft, moist, gray Silt (ML)

Medium stiff, gray, moist, silty Clay (CL) trace sand

very hard, slightly moist, trace to little sand

138-140.5 ft. Shale, gray, highly weathered

Bottom of Hole - Elevation - 444.7
- Depth - 140.5 ft.

Boring grouted with cement at completion.

* Possibly caused by unbalanced hydrostatic head.

For Water Table information consult Section 4.1.3.

SOIL BORING NO. 191

BECHTEL BELLE RIVER

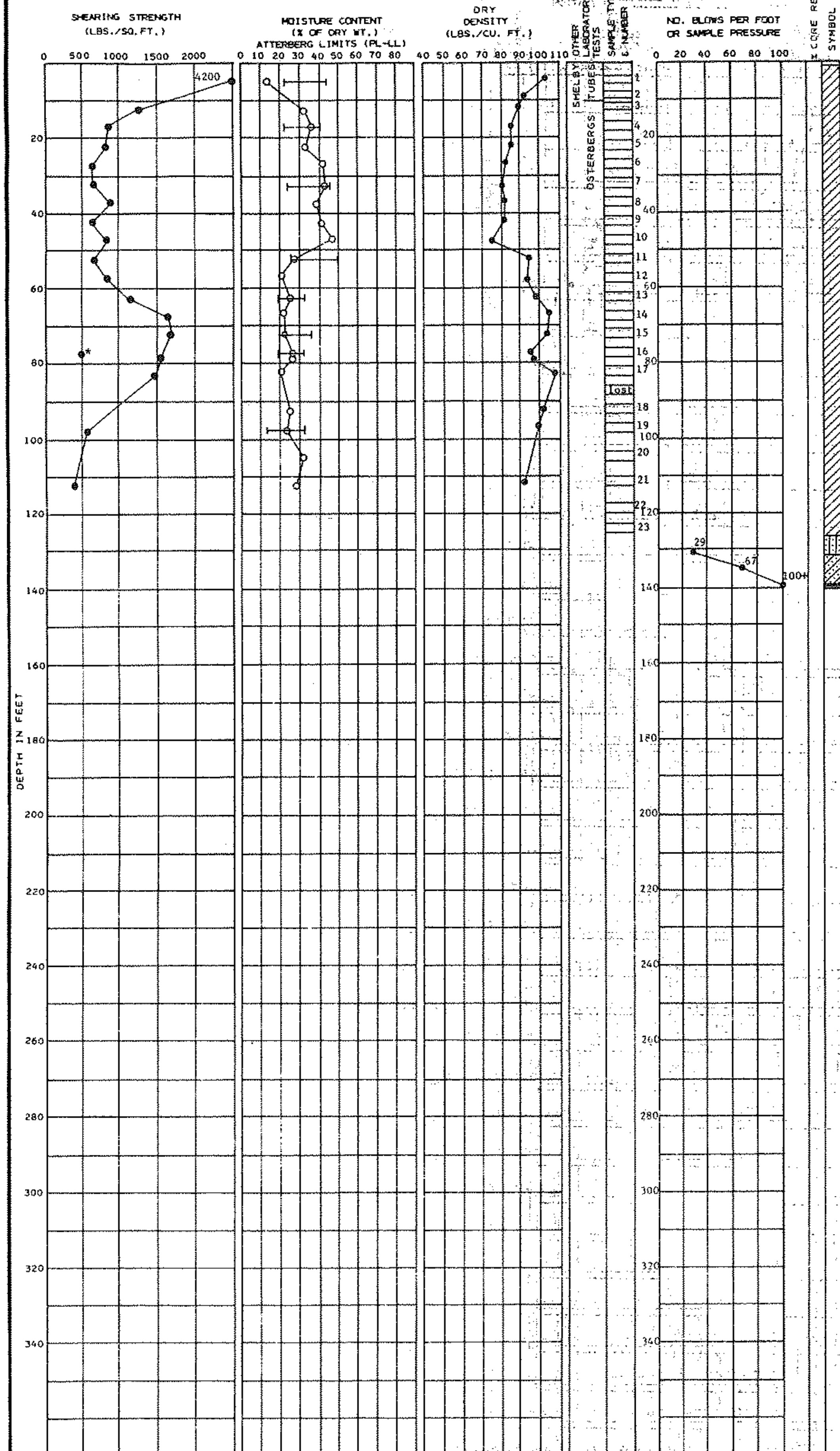
DUNN 10-72

LOCATION: N 3558 E 11701

GROUND ELEVATION 585.2

DATE DRILLED: 8/11/75 8/14/75

SHEET 1 OF 1



DESCRIPTION
Topsoil
Stiff, mottled brown & gray, slightly moist, silty Clay (CL) trace sand
gray, trace sand
medium stiff
soft
slightly stiffer, trace sand
medium stiff, moist, trace to little sand and fine gravel
trace sand and very fine gravel, possible sand or silt seams
more fine gravel
Medium dense, gray, fine to medium Silty Sand (SM)
Very dense, gray, medium coarse Clayey Sand (SC) trace gravel
139.5-140 ft, Shale, gray, very hard, weathered

Bottom of Hole - Elevation - 445.2
- Depth - 140.0 ft.

Boring grouted with cement at completion.

For Water Table information consult Section 4.1.3.

● Unconfined Compression
* Sample contained sand seams.

○ Moisture Content
├─┤ Atterberg Limits

SOIL BORING NO. 193

BECHTEL BELLE RIVER

LOCATION: N 7800 E 9400

GROUND ELEVATION: 585.1

DATE DRILLED: 8/17/77 8/22/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

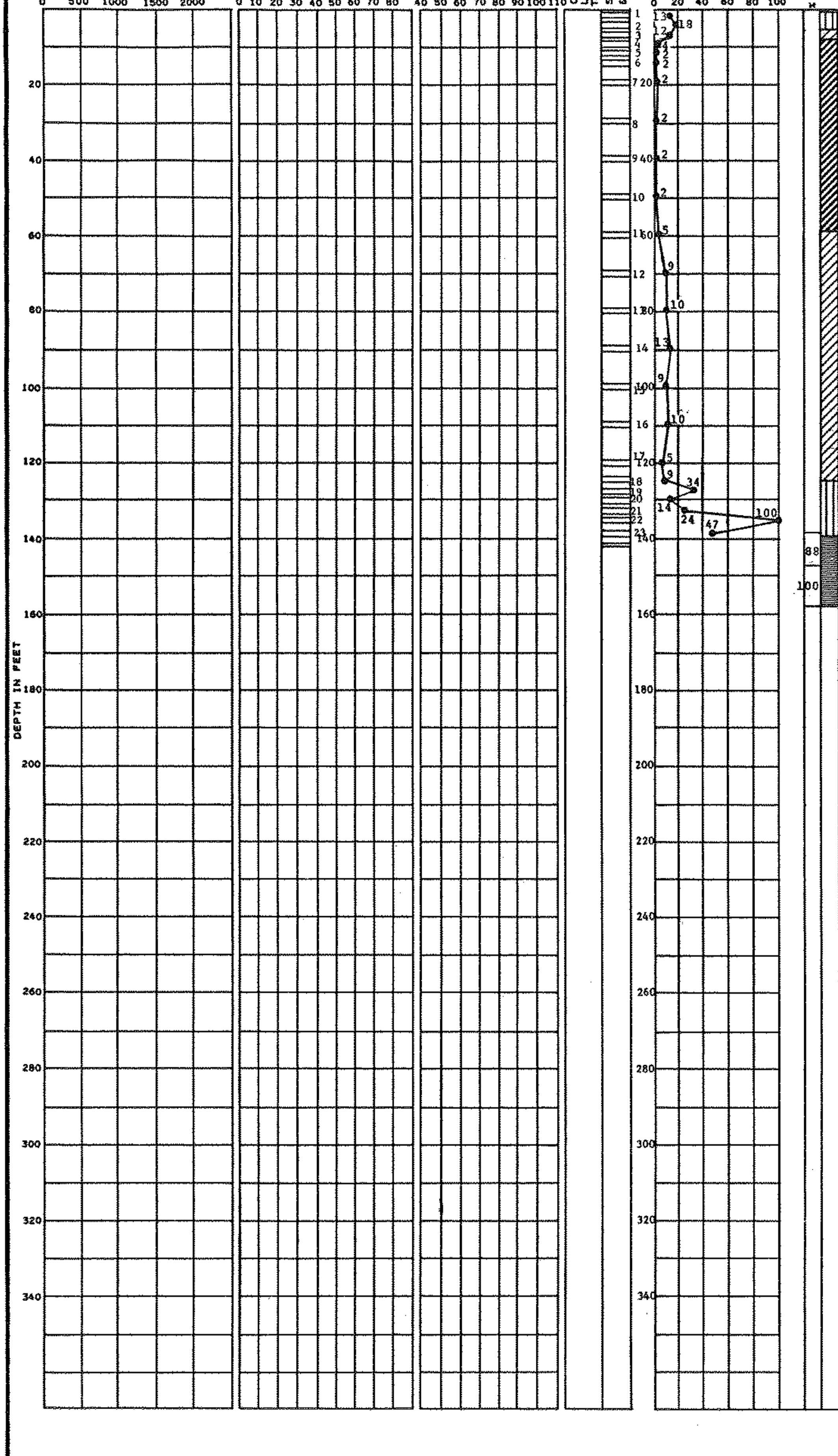
SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET



DESCRIPTION

0-0.5' Topsoil, silty, dark brown, roots

0.5-5.5' Clayey Silt, brown and med. gray, mottled, med. dense, slight plasticity, dry, trace fine to med. gravel (ML)

5.5-8.0' Silty Clay, med. gray, stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)

8.0-58.5' Clay, med. gray, very soft, high plasticity, wet, trace silt, trace fine sand (CH)

58.5-125.5' Silty Clay, med. gray, soft, med. plasticity, moist, trace to little sand, trace fine gravel(CL)
58.5-88.5' Little sand
68.5-88.5' Med. Stiff

88.5-98.5' Stiff
88.5-118.5' Trace sand

98.5-125.5' Med. stiff

105.5-106.0' Small cobbles

118.5-125.5' Occasional fine-grained sand seams

125.5-138.8' Clayey Silt, med. gray, med. dense to dense, moist, with fine-grained sand seams (ML)
127.5-128.3' Fine gravel
134.5-136.3' Boulder
138.1-138.8' Boulder

138.8' Top of Rock
138.8-157.5' Shale, dark gray, soft, friable, slightly fissile, occasional mechanically fractured
149.8-157.5' Harder, scattered, thin black shale stringers

Bottom of Hole: Depth 157.5'
Elevation 427.6

Hole grouted from 157.5' to ground surface.

SOIL BORING NO. B-1

BECHTEL Belle River

LOCATION: N 7600 E 9200

GROUND ELEVATION: 585.0

DATE DRILLED: 8/23/77 – 8/25/77

SHEET 1 OF 1

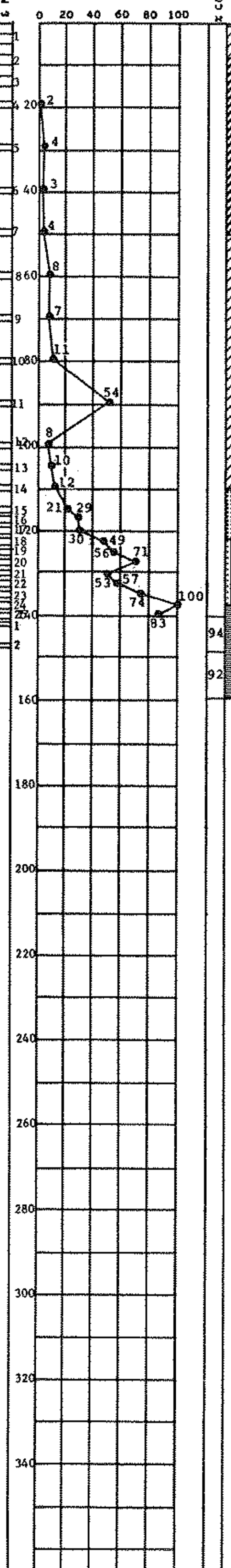
SHEARING STRENGTH (LBS./SQ. FT.): 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL): 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.): 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS | SAMPLE TYPE & NUMBER | NO. BLOWS PER FOOT OR SAMPLE PRESSURE | % CORE RECOVERY | SYMBOL

DEPTH IN FEET: 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340



DESCRIPTION

0-0.5' Topsoil, silty, dark brown, dry

0.5-8.0' Silty Clay, brown and gray, mottled, slight to med. plasticity, moist, trace roots, trace fine to coarse gravel (CL)

8.0-49.5' Clay, med. gray, very soft to soft, high plasticity, wet, trace silt, trace fine gravel (CH)

49.5-109.5' Silty Clay, med. gray, med. stiff, med. plasticity, moist, little sand, trace fine gravel (CL)

78.5-88.5' Stiff

88.5-98.5' Hard

109.5-121.0' Sand, med. gray, med. dense, wet, fine-to med.-grained, trace silt (SP)

121.0-136.5' Silty Sand, med. gray, dense to very dense, moist, fine-grained, trace fine gravel, scattered thin silt seams (SM)

135.5-136.5' Med. gray silt with thin fine-grained sand seams

Cobble on top of rock

136.5' Top of Rock

136.5-158.5' Shale, dark gray, soft, silty, fractures easily, air slakes readily

145.0-148.6' Moderately hard with occasional soft silty layers

148.5-158.5' Hard, massive

150.9-153.5' Very fine-grained, hard, irregularly bedded sandy layers interbedded with shale

156.6-157.5' Soft

Bottom of Hole: Depth 158.5'
Elevation 426.5

Hole grouted from 158.5' to ground surface.

SOIL BORING NO. B-2

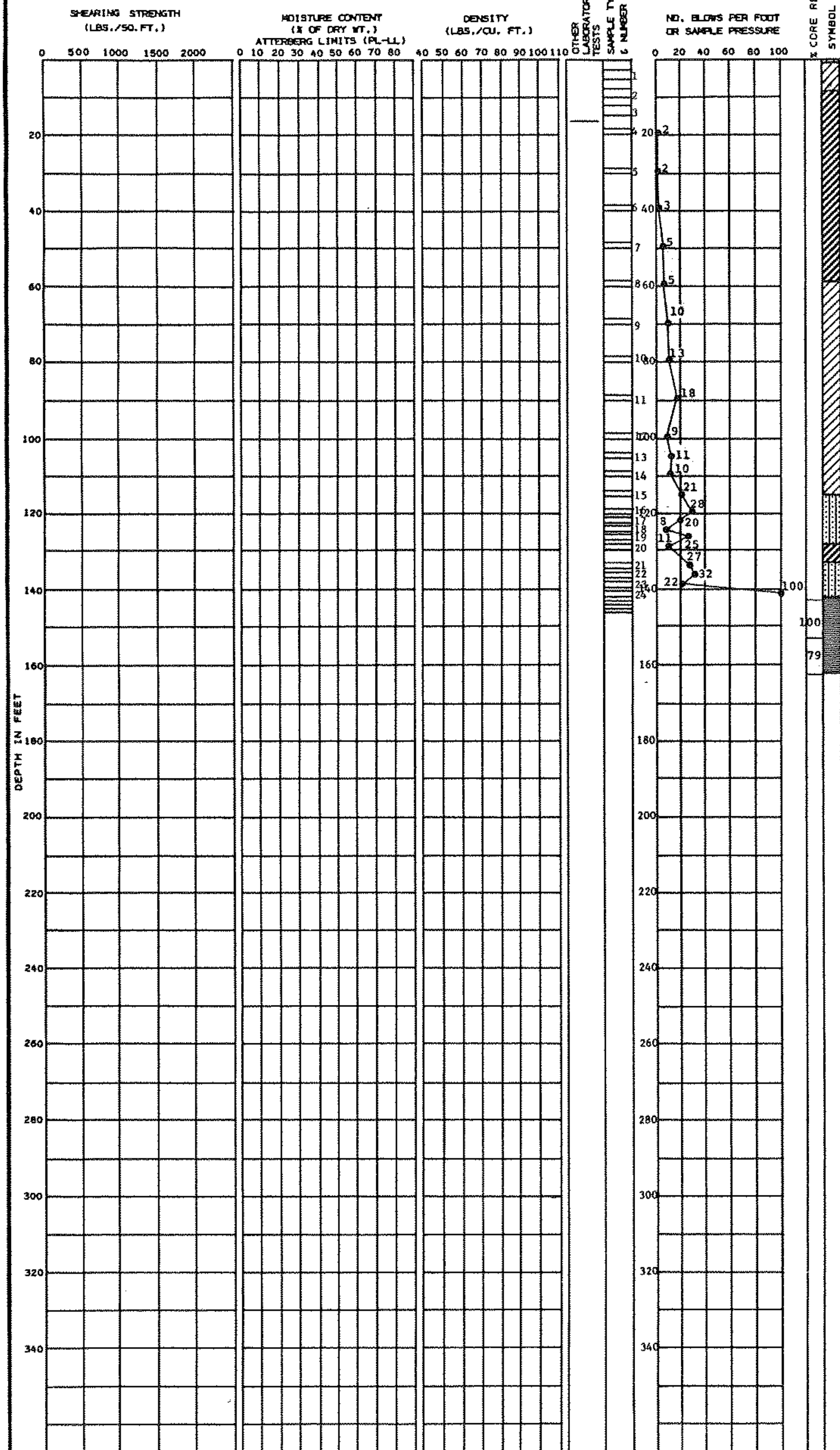
BECHTEL Belle River

LOCATION: N 7850 E 9200

GROUND ELEVATION 585.5

DATE DRILLED: 8/2/77 8/4/77

SHEET 1 OF 1



DESCRIPTION

0-1.0' Topsoil, clayey silt, dark brown to light brown, dry, wood fragments and roots (ML)

1.0-8.5' (?) Silty Clay, med. brown, med. plasticity, moist, trace fine to coarse gravel (CL)

8.5-58.5' Clay, med. gray, very soft, very high plasticity, wet, trace silt, trace fine angular gravel (CH)

46.5-58.5' Soft

58.5-114.5' Silty Clay, med. gray, soft to med. stiff, high plasticity, moist to wet, trace to little fine sand, trace fine to coarse gravel(CL)

78.5-88.5' Stiff

88.5-98.5' Very stiff

98.5-114.5' Stiff to med. stiff
103.5 Less sand, occasional 1/4" pits of red clay
104.0' 1/2" light gray, fine-grained, sand pit
113.5' Trace silt, trace sand

114.5-128.5' Silty Sand, med. gray, med. dense, moist to wet, fine-grained, with thin seams of silt and clay(SH)
123.5-125.0' Loose

128.5-133.3' Clay, med. gray, stiff, high plasticity, wet, trace silt, trace fine gravel, occasional pits of red clay (CH)

133.3-142.0' Silty Sand, med. gray, med. dense to dense, moist to wet, fine-grained, occasional silt and clay seams (SM)
141.7-142.0' Coarse sand seam

142.0' Top of Rock
142.0-162.5' Shale, dark gray, soft, massive, friable
155.0-162.5' Hard
159.0-160.5' Core mechanically fractured

Bottom of Hole: Depth 162.5'
Elevation 423.0

Hole grouted from 162.5' to ground surface.

SOIL BORING NO. B-4

BECHTEL Belle River

LOCATION: N 7600 E 9400

GROUND ELEVATION 584.8

DATE DRILLED: 7/26/77 8/1/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ. FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

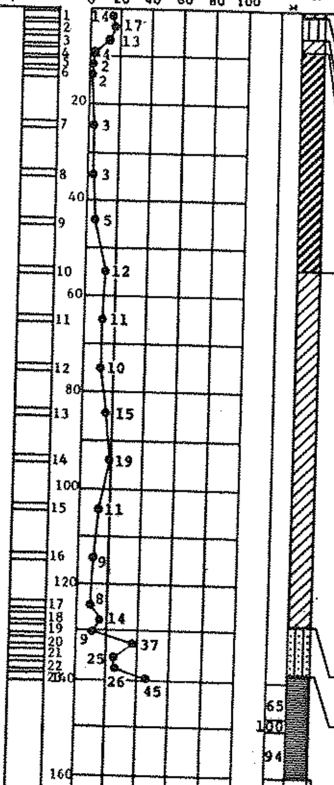
SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET



DESCRIPTION

0-1.0' Silty Clay, topsoil, dark brown to green brown, stiff, slight plasticity, moist, trace sand, with roots and wood fragments (CL)

1.0-6.0' Clayey Silt, light brown to gray, med. dense, dry, trace sand, trace fine gravel (ML)

6.0-8.5' Clay, dark brown, stiff, med. plasticity, moist, trace silt (CL)

8.5-54.0' Clay, med. gray, soft to very soft, very high plasticity, wet, trace fine angular gravel (CH)

54.0-127.5' Silty Clay, med. gray, stiff, med. plasticity, moist, trace sand, trace fine to coarse gravel (CL)

73.5-75.0' Med. stiff

93.5-103.5' Very stiff

103.5-113.5 Stiff

113.5-126.0' Med. stiff

123.5-124.4' Clay seam, high plasticity

124.4-125.0' Silty sand seam, fine-grained, wet

126.0-127.5' Stiff, some sand

127.5-137.8' Silt and Sand, med. gray, med. dense to dense, wet, sand fine-grained (ML and SM)

137.8' Top of Rock

137.8-160.0' Shale, dark blue gray to black, soft, fissile, dry

142.6-144.2' and 154.5-160.0' Core completely fractured into 1/4" or less pieces

150.5-153.0' Core fractured into 1/4" to 4" pieces

Bottom of Hole: Depth 160.0'
Elevation 424.8

Hole grouted from 160.0' to ground surface.

SOIL BORING NO. B-5

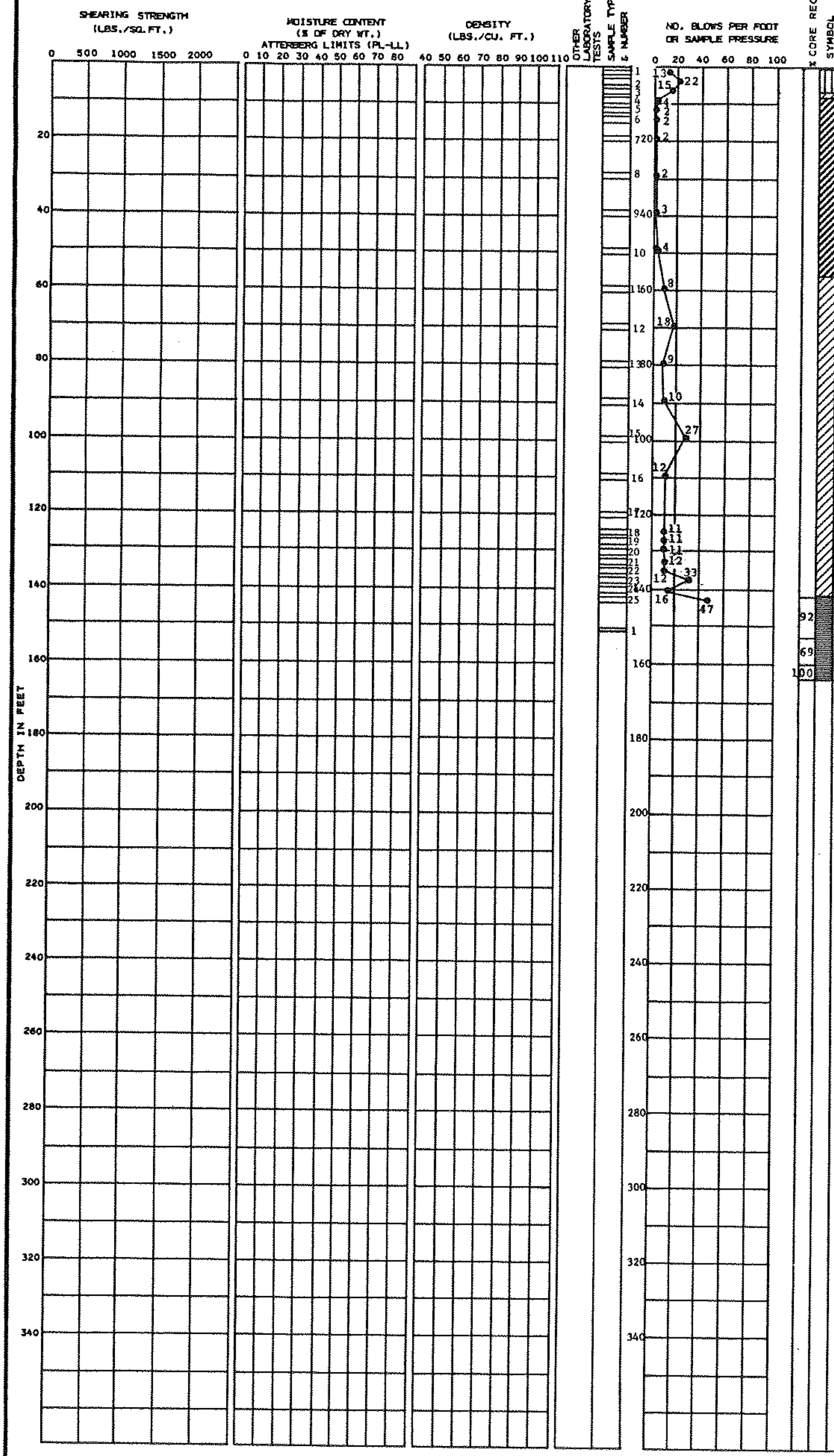
BECHTEL Belle River

LOCATION: N 7650 E 9550

GROUND ELEVATION: 585.7

DATE DRILLED: 8/25/77 8/31/77

SHEET 1 OF 1



DESCRIPTION

0-0.3' Topsoil, dark brown, silty, dry

0.3-7.0' Clayey Silt, brown and gray, mottled, med. dense, none to slight plasticity, dry, abundant wood fragments, trace fine gravel (ML)

7.0-8.5' Silty Clay, med. gray, med. stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)

8.5-56.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt, trace sand, trace fine gravel (CH)
11.0-56.0' Wet

48.5-56.0' Soft

56.0-141.0' Silty Clay, med. gray, med. stiff, med. plasticity, moist, little sand, trace fine gravel (CL)
68.5-78.5' Very stiff

78.5-88.5' Trace sand

88.5-118.5' Little sand

98.5-108.5' Very stiff

108.5-136.0' Stiff

123.5-125.0' Scattered, fine-grained sand seams

130.5-133.5' Scattered silt and fine-grained sand seams
133.5-136.0' Silt with silty clay seams, wet
136.0-138.5' Dense, fine-grained silty sand, wet, trace med. gravel
138.5-141.0' Very stiff clayey silt with fine-grained sand seams, wet

141.0' Top of Rock
141.0-163.5' Shale, med. gray, soft to firm, massive to slightly fissile, occasional interbeds of soft clay, shale air slakes rapidly, core mechanically fractured.
150.0-158.8' Hard, with very thin sandy interbeds

Bottom of Hole: Depth 163.5'
Elevation 422.2

Hole grouted from 163.5' to ground surface.

SOIL BORING NO. B-6

BECHTEL Belle River

LOCATION: N 8180 E 9550

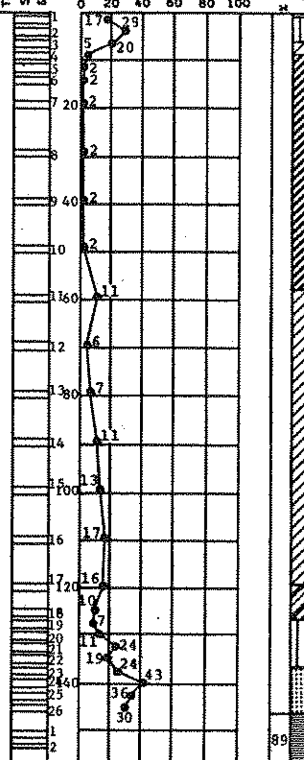
GROUND ELEVATION: 585.3

DATE DRILLED: 8/12/77 8/17/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	% CORE RECOVERY	SYMBOL	DESCRIPTION
0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100			

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340



DESCRIPTION

0-0.5' Topsoil, silty dark brown

0.5-6.0' Clayey Silt, light gray and med. brown, mottled, med. dense, slight plasticity, dry, trace fine gravel, roots (ML)

6.0-8.5' Silty Clay, med. brown, very stiff, med. plasticity, very stiff, med. plasticity, moist, trace fine gravel (CL)

8.5-57.0' Clay, med. gray, soft to very soft, high plasticity, wet, trace silt (CH)

48.5' Trace fine to med. gravel

57.0-118.5' Silty Clay, med. gray, stiff, med. plasticity, moist, trace to little sand, trace fine gravel(CL)
68.5-88.5' Med. stiff

78.5-118.5' Little fine sand

108.5-118.5' Very stiff

118.5-125.5' Clay, med. gray, very stiff, med. plasticity, moist, trace silt (CL-CH)
123.5-125.5' Med. stiff

125.5-135.5' Clayey Silt, med. gray, loose to med. dense, wet, trace sand occasional fine to med.-grained sand seams (ML)
128.5-131.0' Sandy silt
131.0-132.0' Fine-grained silty sand seam

135.5-145.0' Sand, gray and brown, med. dense to dense, wet, fine-to med. grained, trace silt (SP)
143.5-144.5' Clayey sand

145.0' Top of Rock
145.0-164.0' Shale, green-gray, hard, occasional irregular bedding with very fine black coal stringers, predominately massive
148.7-149.3' Very fine-grained, hard, irregularly bedded sandy layers inter-bedded with shale
162.7-164.0' Soft dark gray, dry, friable

Bottom of Hole: Depth 164.0'
Elevation 421.3

Hole grouted from 164.0' to ground surface.

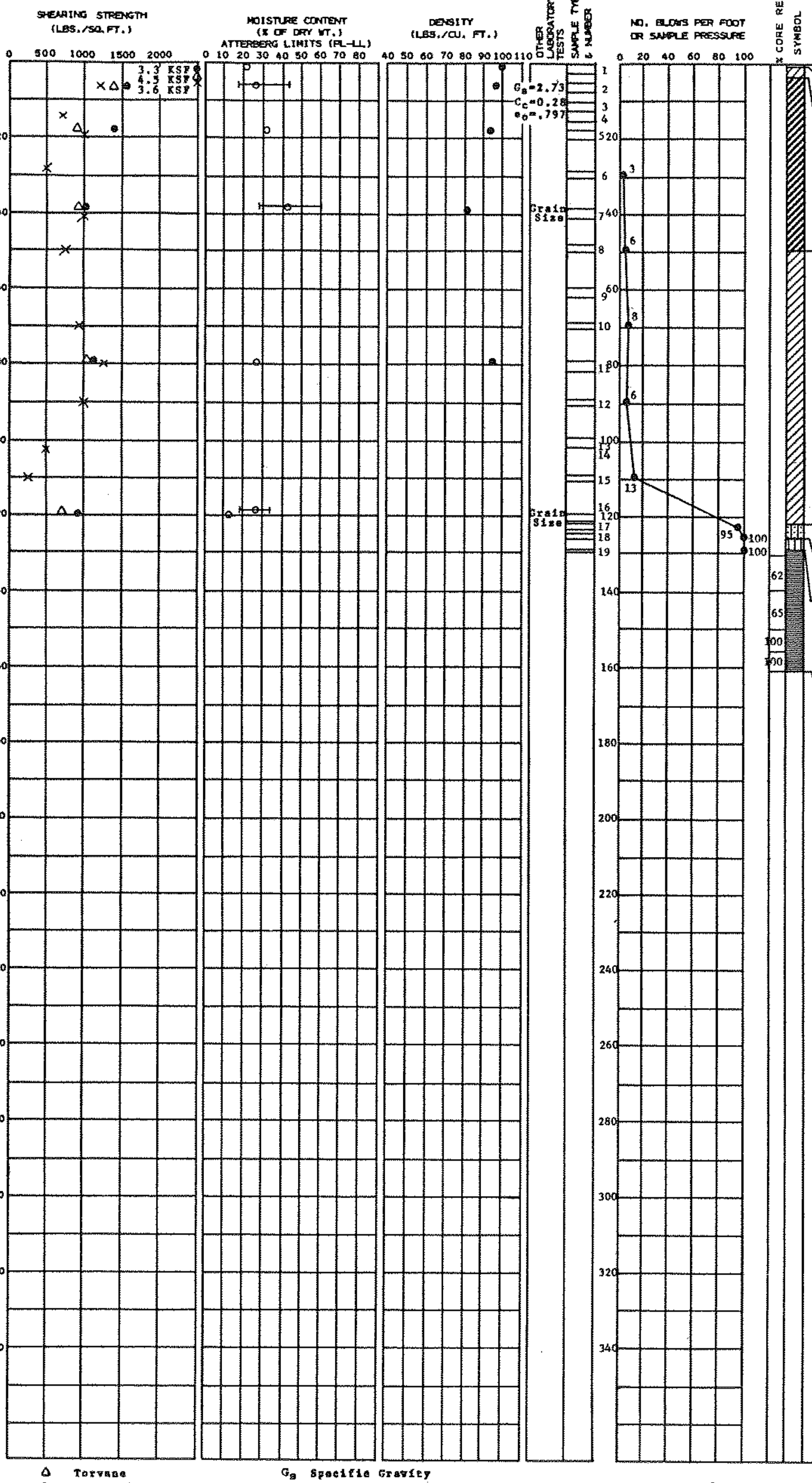
SOIL BORING NO. B-13

BECHTEL Belle River

LOCATION: N 5270 E 15660 GROUND ELEVATION 580.0

DATE DRILLED: 9/7/77 9/14/77

SHEET 1 OF 1



DESCRIPTION

0-0.5' Topsoil, dark brown, dry

0.5-3.0' Silty Clay, med. brown, gray and black, mottled, slight to med. plasticity, moist, trace fine gravel (CL)

3.0-48.5' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt (CH)

48.5-120.5' Silty Clay, dark gray, med. stiff, med. plasticity, moist, little sand, trace fine to med. gravel (CL)

108.5-120.5' Stiff, trace sand

118.5'-120.4' Seams of silt, clayey sand, and silty sand

120.5-124.6' Silty Sand, med. gray, very dense, moist, fine to med.-grained, trace fine gravel, occasional silt seams (SM)

124.6-128.0' Clayey Silt, med. gray, very dense, dry, trace fine gravel (ML)

128.0' Top of Rock

128.0-159.5' Shale, dark grey, soft, weathered, fragments as abstracted from core barrel

151.3' Slightly harder with soft lenses, splits easily

155.0' Moderately hard core broken every 1"-2"

Bottom of Hole: Depth 159.5'
Elevation 420.5

Hole grouted from 159.5' to ground surface.

Discovered gas in hole when removing casing.

△ Torvane
○ Unconsolidated Undrained
● Unconfined Compression
├─┤ Atterberg Limits
G_s Specific Gravity
C_c Compression Index
e_o Initial Void Ratio
✕ Pocket Penetrometer

SOIL BORING NO. B-17

BECHTEL Belle River

LOCATION: N 5163 E 15744

GROUND ELEVATION: 577.5 (Top of Water)

DATE DRILLED: 9/21/77 9/27/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

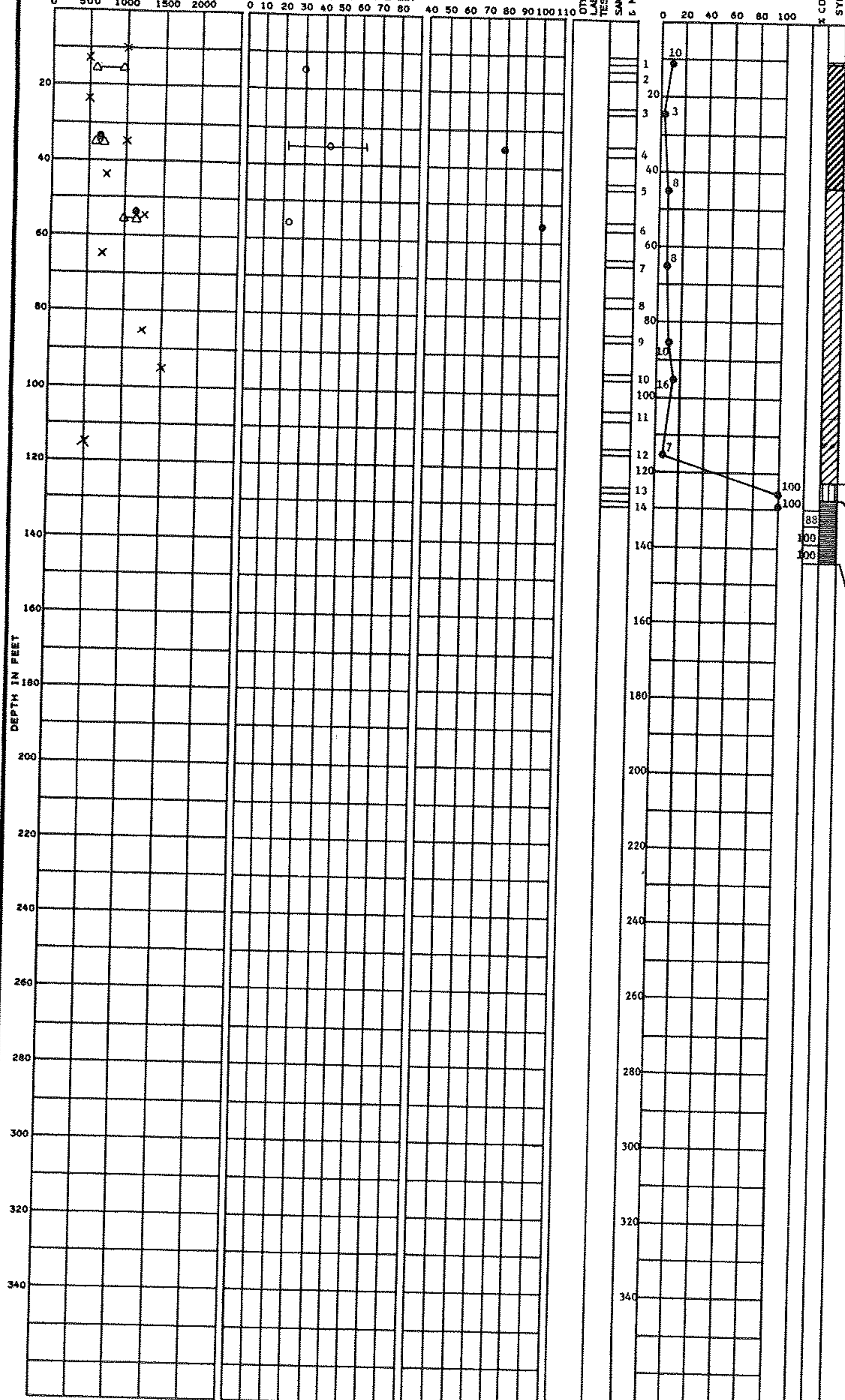
OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL



DESCRIPTION

0-10.0' Water

10.0-10.3' Sandy Clay, dark gray to black, very soft, wet, trace fine to coarse gravel (CL)

10.3-43.5' Clay, gray-brown, med. stiff, high plasticity, moist to wet, trace silt (CH)

18.0-43.5' Very soft

43.5-122.0' Silty Clay, med. gray, med. stiff, med. plasticity, moist, trace to little sand, trace fine gravel (CL)

93.5-113.5' Very stiff, trace sand

113.5-122.0' Med. stiff, trace silt, trace sand

122.0-127.0' Silt, light gray, very dense, dry, with fine sand (ML)

127.0' Top of Rock

127.0-144.0' Shale, med. gray, soft, weathered

131.7-144.0' Moderately hard with soft clay interbeds

139.0-144.0' Occasional soft clay layers

Bottom of Hole: Depth 144.0' Elevation 433.5

Hole grouted from 127.0' to ground surface.

△ Torvane
⊢ Atterberg Limits
● Unconfined Compression
○ Unconsolidated Undrained
X Pocket Penetrometer

SOIL BORING NO. B-22

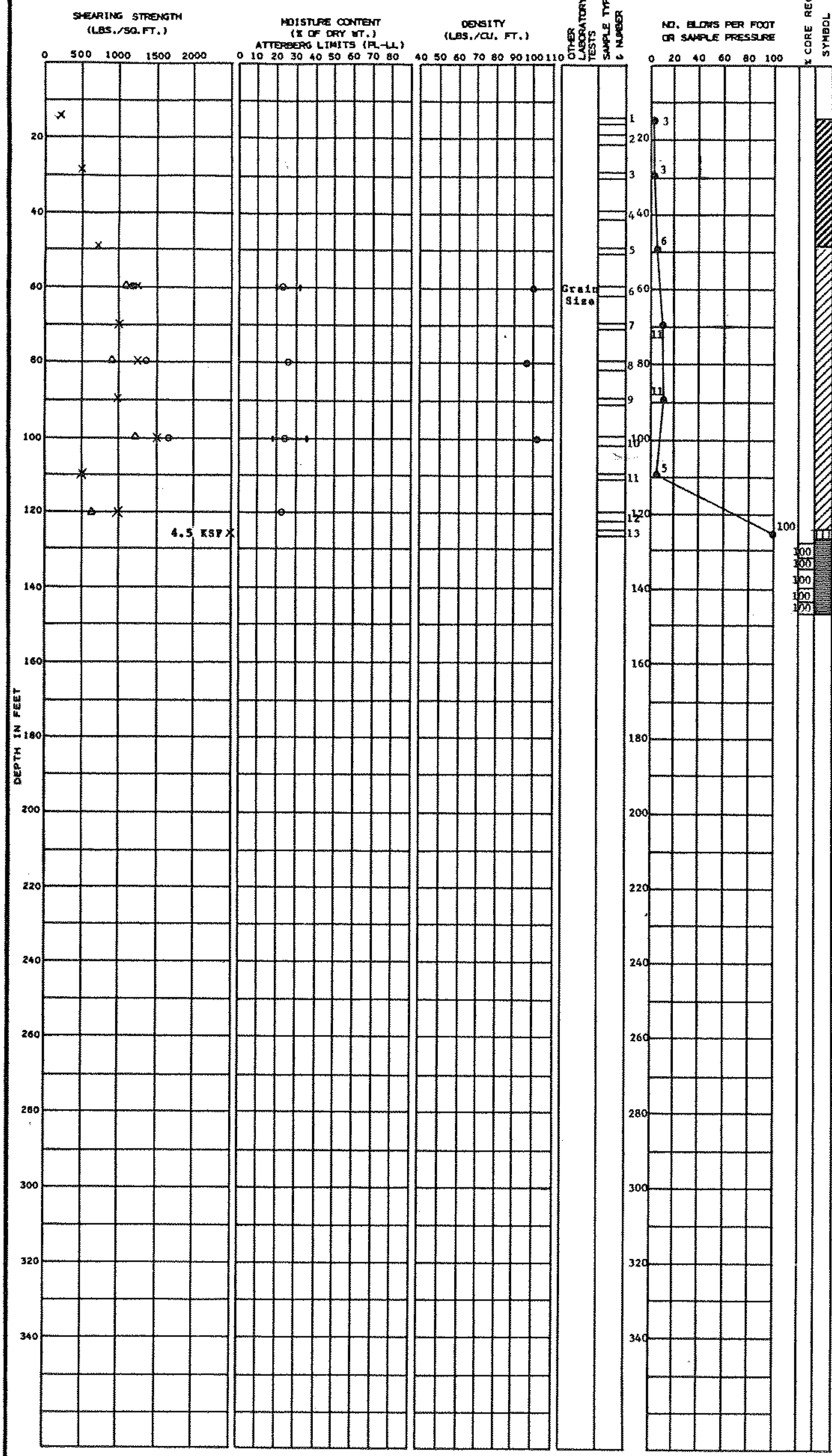
BECHTEL Belle River

LOCATION: N 5364 E 15750

GROUND ELEVATION: 577.5 (Top of Water)

DATE DRILLED: 9/15/77 9/21/77

SHEET 1 OF 1



DESCRIPTION

0-14.0' Water

14.0-47.5' Clay, light gray-brown, very soft, high plasticity, wet, trace silt (CH)

47.5-123.0' Silty Clay, med. gray, med. stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)

68.5-108.5' Stiff

100.3' Gray, sandy

108.5-123.0' Soft
118.5'-121.2' Layers of clay, silt, clayey sand, and silty sand

123.0-126.5' Silt with fine-grained sand seams, med. gray, very dense, trace fine gravel (ML)

126.5' Top of Rock
126.5-146.4' Shale, dark gray, very soft, weathered
128.8-132.5' Soft
132.5-146.4' Moderately hard with interbeds of soft clay, core breaks easily

Bottom of Hole: Depth 146.4'
Elevation 431.1

Hole grouted from 146.4' to ground surface.

△ Torvane
○ Unconsolidated Undrained
● Unconfined Compression
├─┤ Atterberg Limits
× Pocket Penetrometer

SOIL BORING NO. B-23

BECHTEL Belle River

LOCATION: N 7113 E 11039

GROUND ELEVATION: 588.5

DATE DRILLED: 9/1/77 9/1/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

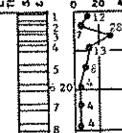
SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET



DESCRIPTION

0-0.8' Topsoil, dk. brown, dry

0.8-4.0' Clayey Silt, yellow to med. brown, med. dense, dry, trace sand, trace fine to coarse gravel, roots (ML)

4.0-17.0' Silty Clay, dk. brown and gray, mottled, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine to coarse gravel (CL)
9.0' Med. brown
13.5' Med. gray

17.0-30.0' Clay, med. gray, soft, high plasticity, moist to wet, trace silt, trace sand, trace fine gravel (CH)

Bottom of Hole: Depth 30.0'
Elevation 558.5

Hole backfilled with cuttings.

SOIL BORING NO. B-24

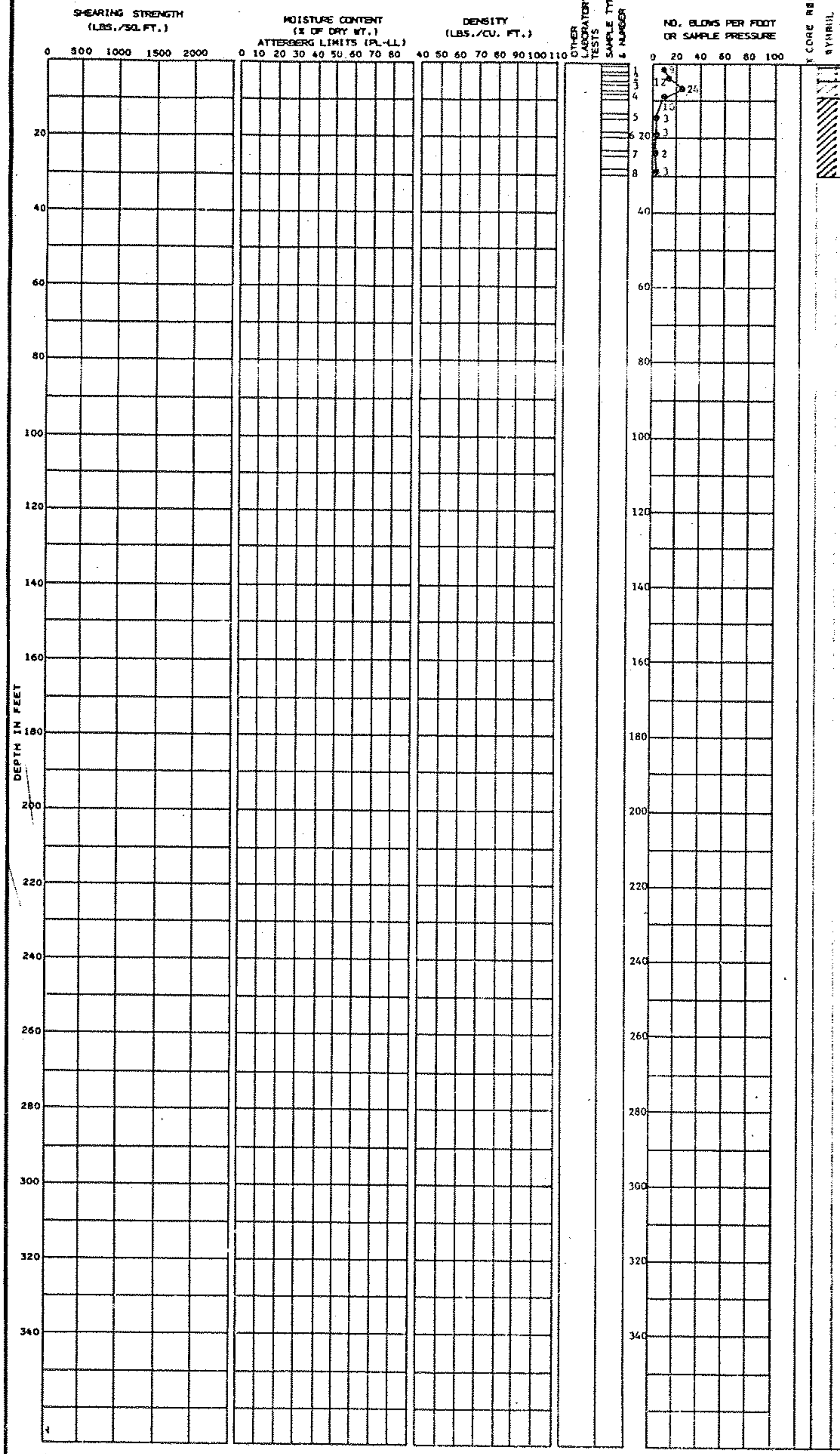
BECHTEL Belle River

LOCATION: N 6921 E 11501

GROUND ELEVATION 587.5

DATE DRILLED: 9/1/77 9/1/77

SHEET 1 OF 1



DESCRIPTION

0-0.7' Topsoil, dk. brown, dry

0.7-4.5' Silty Sand, tan and yellow, mottled, loose, damp, fine-grained (SM)

4.5-9.0' Silty Clay, brown and gray, mottled, stiff to very stiff, med. plasticity, moist, trace sand, trace fine to coarse gravel (CL)

9.0-30.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace sand, trace fine gravel, trace silt (CH)

Bottom of Hole: Depth 30.0'
Elevation 557.5

Hole backfilled with cuttings.

SOIL BORING NO. B-26

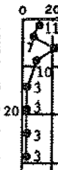
BECHTEL Belle River

LOCATION: N 6730
E 11963

GROUND ELEVATION 588.1

DATE DRILLED: 9/1/77
9/1/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80	DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110	OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100	% CORE RECOVERY	SYMBOL	DESCRIPTION
				1, 2, 3, 4, 5, 6, 7, 8				0-0.7' Topsoil, dr. brown, dry 0.7-4.0' Silty Sand, tan and gold, mottled, med. dense, dry, fine-grained, roots (SM) 4.0-13.5' Silty Clay, gray and brown, mottled, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL) 6.0' Green brown 13.5-30.0' Clay, med. gray, soft, high plasticity, moist to wet, trace silt, trace fine gravel (CH) Bottom of Hole: Depth 30.0' Elevation 558.1 Hole backfilled with cuttings.

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

SOIL BORING NO. B-28

BECHTEL Belle River

DURN 10-72

LOCATION: N 6539 E 12425

GROUND ELEVATION 588.2

DATE DRILLED: 9/2/77 9/2/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

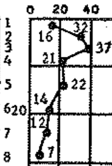
MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER: 1, 2, 3, 4, 5, 6, 7, 8

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100



% CORE RECOVERY

SYMBOL

DEPTH IN FEET: 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340

DESCRIPTION

0-1.0' Topsoil, dk. brown, silty, fine to med. gravel, dry (GM)

1.0-5.0' Clayey Silt, dk. brown, med. dense to dense, dry, trace sand, trace fine gravel (ML)

5.0-30.0' Silty Clay, dk. brown, hard to very stiff, dry, med. plasticity, trace sand, trace fine to med. gravel (CL)

13.5' Moist, dipping parting in sample, med. brown with med. gray filling, with roots

19.0-28.5' Med. gray, stiff

23.5' green-brown and gray, mottled

28.5-30.0' Med. gray, med. stiff

Bottom of Hole: Depth 30.0'
Elevation 558.2

Hole backfilled with cuttings.

SOIL BORING NO. B-30

BECHTEL Belle River

LOCATION: N 6348 E 12890

GROUND ELEVATION 600.0

DATE DRILLED: 9/1/77 9/1/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

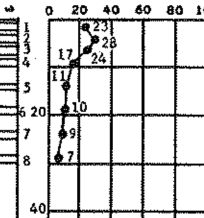
SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET



DESCRIPTION

0-1.0' Topsoil, dk. brown, silty, dry, sandy fill with coarse gravel

1.0-6.0' Clayey Silt, green brown, med. dense, dry, trace sand (ML)

6.0-30.0' Silty Clay, green brown, very stiff, slight plasticity, moist, trace sand, trace fine gravel (CL)
13.5' Med. gray, stiff to med. stiff, med. plasticity

28.5-30.0' Med. to high plasticity

Bottom of Hole: Depth 30.0'
Elevation 570.0

Hole backfilled with cuttings.

SOIL BORING NO. B-32

BECHTEL Belle River

LOCATION: N 6156 E 13349

GROUND ELEVATION 598.8

DATE DRILLED: 9/2/77 9/2/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.)

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)

DENSITY (LBS./CU. FT.)

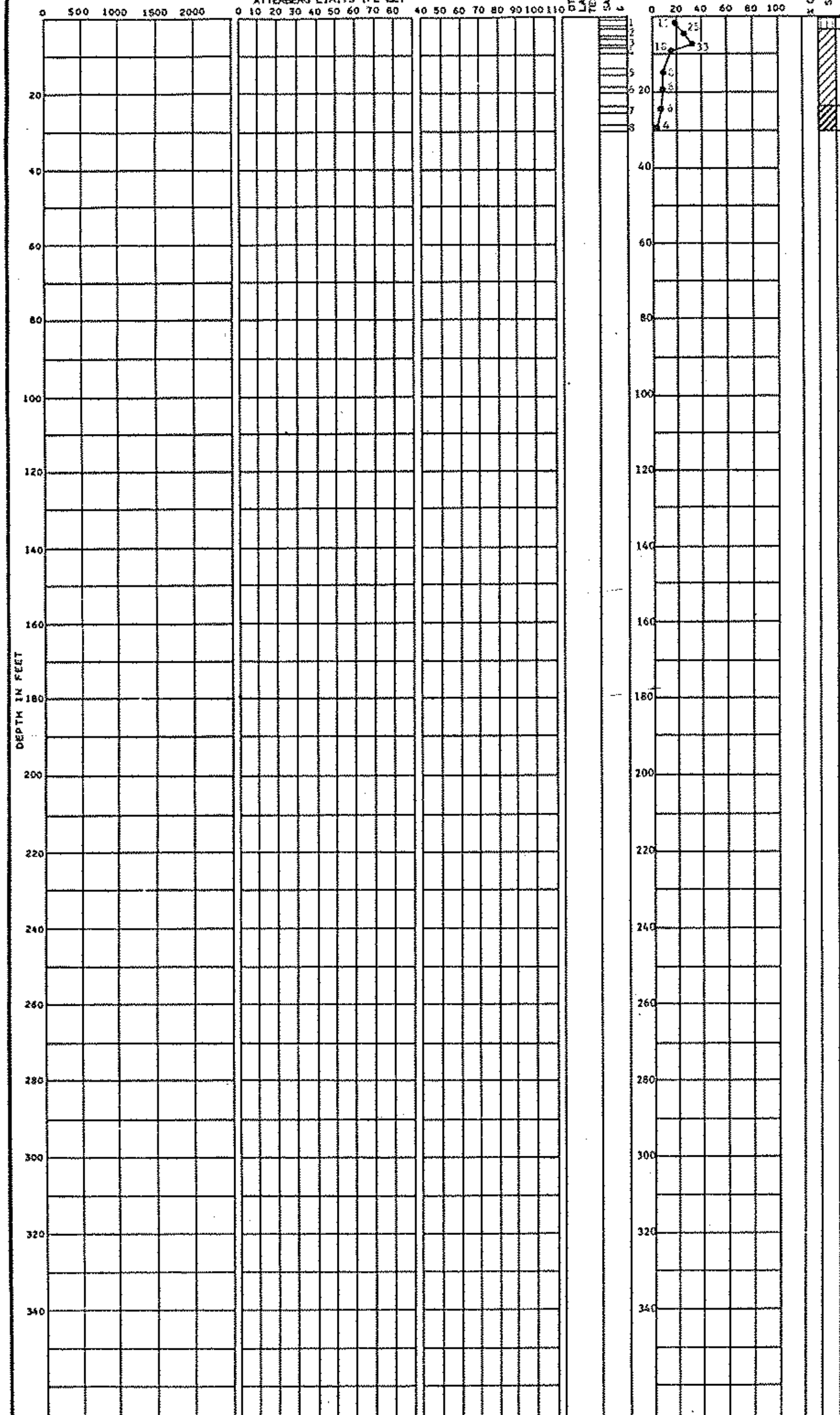
OTHER LABORATORY TESTS

SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE

% CORE RECOVERY

SYMBOL



DESCRIPTION

0-0.3' Topsoil, dk. brown, dry

0.3-3.5' Clayey Silt, light brown and gray, mottled, med. dense, none to slight plasticity, dry, trace sand, trace fine to coarse gravel (ML)

3.5-23.5' Silty Clay, med. brown and gray, lightly mottled, very stiff to hard, med. plasticity, moist, trace sand, trace fine gravel (CL)
13.5-23.5' Med. gray, med. stiff

23.5-30.0' Clay, med. gray, soft to very soft, high plasticity, moist, trace silt (CH)

Bottom of Hole: Depth 30.0'
Elevation 568.8

Hole backfilled with cuttings.

SOIL BORING NO. B-34

BECHTEL Belle River

LOCATION: N 52[illegible]5 / E 13[illegible]1[illegible]

GROUND ELEVATION: 591.5

DATE DRILLED: 9/2/77 – 9/2/77

SHEET 1 OF 1

SHEARING STRENGTH (LBS./SQ.FT.) 0 500 1000 1500 2000

MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL) 0 10 20 30 40 50 60 70 80

DENSITY (LBS./CU. FT.) 40 50 60 70 80 90 100 110

OTHER LABORATORY TESTS

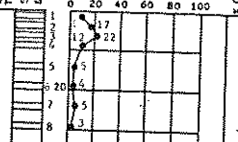
SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT OR SAMPLE PRESSURE 0 20 40 60 80 100

% CORE RECOVERY

SYMBOL

DEPTH IN FEET: 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340



DESCRIPTION

0-0.4' Topsoil, dk. brown, dry

0.4-14.0' Silty Clay, dk. brown and gray, mottled, very stiff to med. stiff, slight plasticity, moist, trace sand, trace fine gravel (CL)
3.5-5.0' Scattered stringers of calcium carbonate
8.5-14.0' Med. brown

14.0-30.0' Clay, med. gray, soft to very soft, high plasticity, moist, trace silt (CH)

Bottom of Hole: Depth 30.0'
Elevation 561.5

Hole backfilled with cuttings.

SOIL BORING NO. B-38

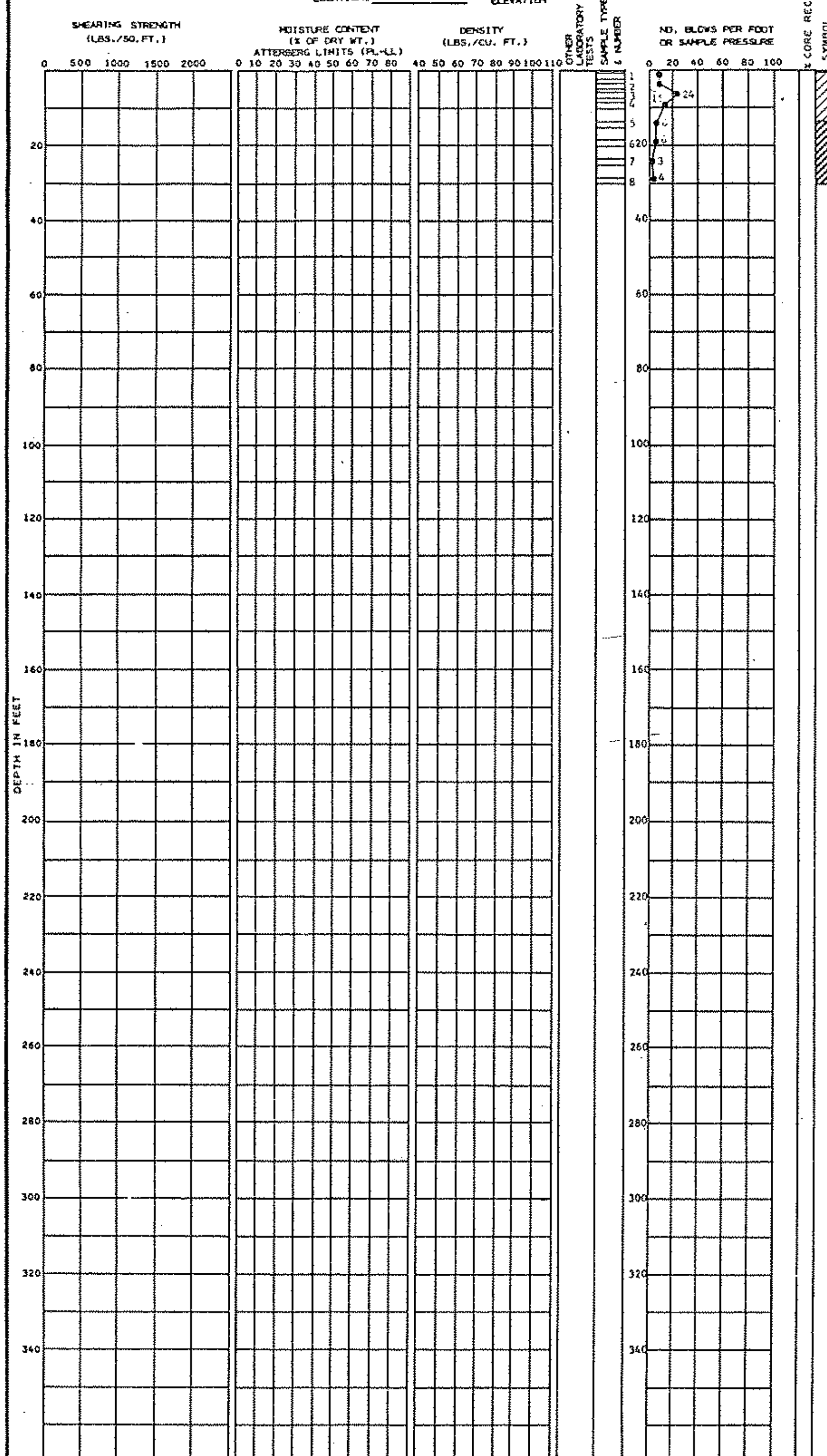
BECHTEL Belle River

LOCATION: N 5774 E 14272

GROUND ELEVATION 591.2

DATE DRILLED: 9/6/77 9/6/77

SHEET 1 OF 1



DESCRIPTION

0-0.3' Topsoil, dk. brown, moist

0.3-13.5' Silty Clay, med. brown and gray, mottled, med. stiff, med. plasticity, trace sand, trace fine gravel (CL)
6.0-8.5' Med. brown, very stiff
8.5-13.5' Med. brown, stiff

13.5-30.0' Clay, med. gray, med. stiff, high plasticity, moist, trace silt (CH)
23.5-28.5' Very soft, moist to wet
28.5-30.0' Soft

Bottom of Hole: Depth 30.0'
Elevation 561.2

Hole backfilled with cuttings.

SOIL BORING NO. B-39

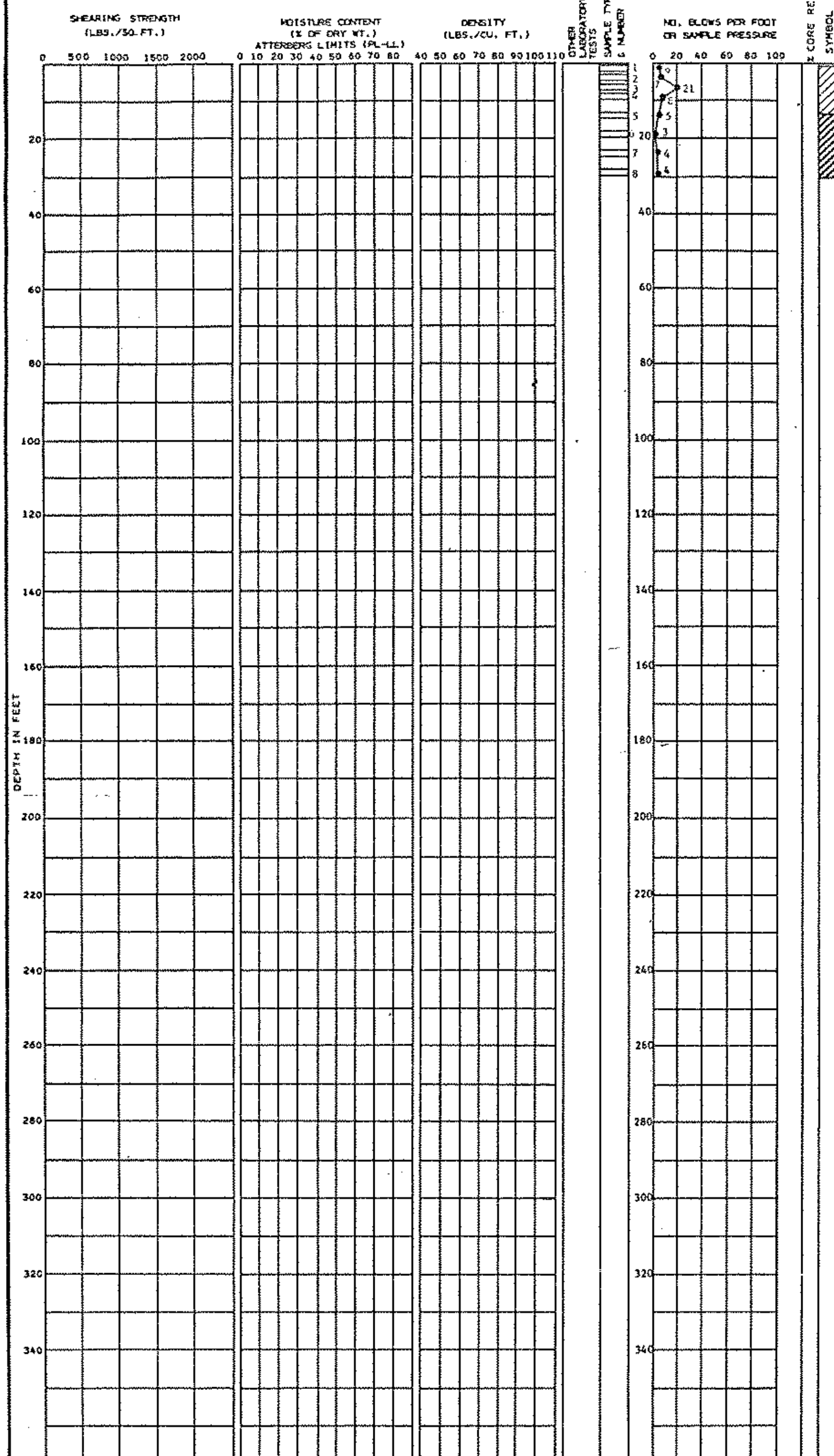
BECHTEL Belle River

LOCATION: N 5582 E 14735

GROUND ELEVATION 590.2

DATE DRILLED: 9/6/77 9/6/77

SHEET 1 OF 1



DESCRIPTION

0-0.4' Topsoil, dk. brown, dry

0.4-13.5' Silty Clay, med. brown, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)

13.5-30.0' Clay, med. gray, soft to very soft, high plasticity, moist to wet, trace silt (CH)

Bottom of Hole: Depth 30.0'
Elevation 560.2

Hole backfilled with cuttings.

SOIL BORING NO. B-40

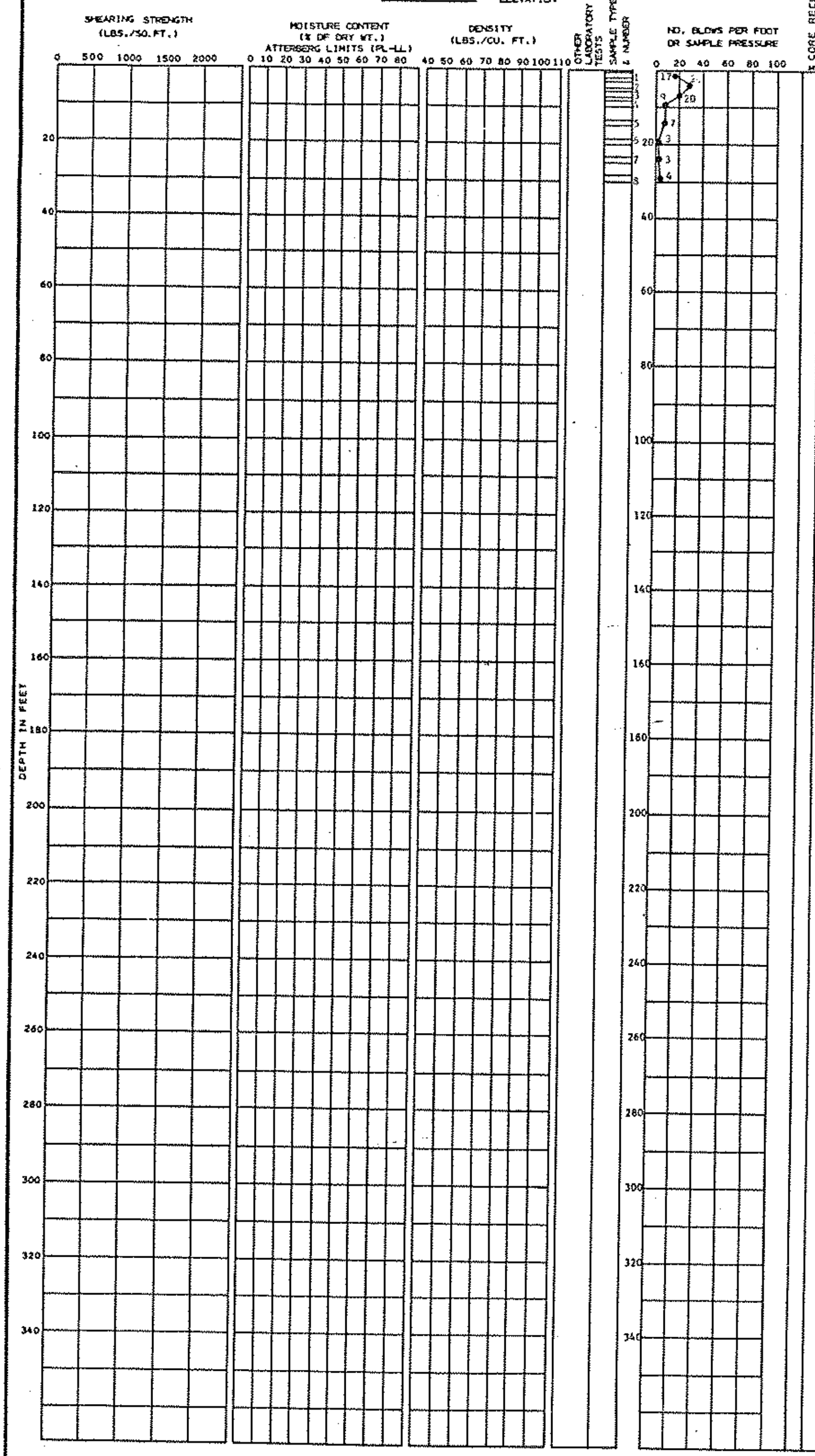
BECHTEL Belle River

LOCATION: N 5356 E 15253

GROUND ELEVATION: 589.9

DATE DRILLED: 9/6/77 9/6/77

SHEET 1 OF 1



DESCRIPTION

0-0.3' Topsoil, dk. brown, dry

0.3-4.0' Clayey Silt, light brown, med. dense, dry, trace sand, trace fine to coarse gravel (ML)

4.0-18.5' Silty Clay, med. brown and gray, mottled, very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)

8.5-18.5' Med. stiff

18.5-30.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt (CH)

28.5-30.0' Soft

Bottom of Hole: Depth 30.0'
Elevation 559.9

Hole backfilled with cuttings.

SOIL BORING NO. B-42

BECHTEL Belle River